16.53
416
578
Illinois U Library

PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

THE PHYSICAL SOCIETY

THE AMERICAN PHYSICAL SOCIETY

THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

ABSTRACTS 2116–2843

VOLUME 53 **APRIL 1950** NUMBER 628

A Perfect 'Deal'

A ◆ COMPLETE VACUUM INSTALLATIONS

K ◆ AUXILIARY EQUIPMENT

Q ◆ HIGH VACUUM GAUGES

J ◆ OIL & MERCURY DIFFUSION PUMPS

10 ◆ 'SPEEDIVAC' ROTARY PUMPS

. . . For Better Vacuum Service . . .

W. EDWARDS & CO. (LONDON) LTD.

LOWER SYDENHAM · LONDON · S.E.26

Telephone: SYDenham 7026 (8 lines). Telegrams: EDCOHIVAC, Souphone, London

Principal Contents

APRIL 1950

		PAGE
51	MATHEMATICS	269
52	ASTRONOMY. ASTRO-PHYSICS. GEODESY	269
53	PHYSICS	275
530.1	Fundamentals	275
531	General mechanics. Mechanics of solids	278
531.7	Mechanical measurements	279
532	Mechanics of fluids	280
532.6	Capillarity	282
532.7	Molecular theory of liquids	282
533	Mechanics of gases	283
533.7	Molecular theory of gases	284
534	Vibrations. Acoustics	285
535	Optics. Radiation. Spectra	290
536	Heat	301
536.7/.8	Thermodynamics	306
537	Electricity	306
537.1	Theory. Electrons	306
537.2	Electrostatics. Dielectrics	307
537.3	Electric conduction. Currents	308
537.52	Electric discharges	311
537.531	X-rays	313
537.533/.534	Cathode rays. Positive rays	316
537.54	Discharge tubes. Counters	318
537.56/.58	Ionization. Thermionics	319
537.591	Cosmic rays	320
538	Magnetism	324
538.3/.5	Electromagnetism. Electrodynamics	327
538.6	Magnetic effects	329
539.1	Molecular and atomic structure	—
539.11	Theory of solid state	—
539.13	Molecular structure	330
539.15	Atomic structure. Isotopes	331
539.16	Radioactivity. α-, β- and γ-rays	332
539.17	Nuclear reactions	335
539.18	Atom and molecule beams. Mesons. Neutrons	338
539.2	Structure of solids	340
539.3/.8	Elasticity. Strength. Rheology	342
541	PHYSICAL CHEMISTRY	344
541.11/.12	Phase equilibrium. Chemical reactions	344
541.13	Electrochemistry	345
541.14	Photochemistry. Radiation chemistry	345
541.18	Dispersions. Colloids. Adsorption	346
541.4/.6	Chemical structure	346
542.1/.7	Laboratory apparatus	—
543/545	Chemical analysis	346
548	CRYSTALLOGRAPHY	347
548.7	Molecular and X-ray crystallography	348
55	GEOPHYSICS	351
551.5	Atmosphere. Meteorology	352
57/59	BIOLOGY	354
61	Medical science. Human physiology	355
66/67	TECHNICAL MATERIALS	—
77	PHOTOGRAPHY	356

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Mechanical testing
Non-destructive testing
Industrial radiography
Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements that published with the January Number of Vol. 53 (1950). Journ marked * are not received regularly though abstracts of articles from them are occasionally published. addresses given are believed to be correct, but no responsibility can be accepted for errors.

**Analyst*	*Analyst.* W. Heffer and Sons, Ltd., Cambridge.
Brit. Elect. Lab. Mem.	*British Electricity Laboratories Memoir.* Randall's Farm La Kingston Road, Leatherhead.
**Bull. Soc. Roy. Sci. Liége*	*Bulletin de la Société Royale des Sciences de Liége.* [Abstracted *Photographic Abstracts.*]
Ciencia, México	*Ciencia.* Apartado Postal 21033, México, D.F.
Diss. E.T.H., Zürich	*Dissertation der Eidgenössischen Technischen Hochschule in Zür* Clausiusstrasse 13, Zürich.
Elect. Mfr	*The Electrical Manufacturer.* Morley House, 26–30 Holborn Viadu E.C.1.
Harv. Coll. Obs. Center Anal. Mass. Inst. Techn. Tech. Rep.	*Harvard College Observatory and Center of Analysis of Massachuse Institute of Technology Technical Report.* Cambridge, Mas chusetts.
**Iron Coal Tr. Rev.*	*Iron and Coal Trades Review.* [Abstracted by *Metropolitan-Vicki Electrical Co., Ltd.*]
J. Soc. Mot. Pict. Televis. Engrs	*Journal of the Society of Motion Picture and Television Enginee* [Formerly *Journal of the Society of Motion Picture Engineers.*]
**Machinery, Lond.*	*Machinery.* [Abstracted by *Metropolitan-Vickers Electrical Co. Lt*
**Mag. Concr. Res.*	*Magazine of Concrete Research.* Cement and Concrete Associati 52 Grosvenor Gardens, S.W.1.
Marconi Rev.	*Marconi Review.* Marconi Wireless Telegraph Company, Elec House, Victoria Embankment, London, W.C.2.
Proc. Nova Scotian Inst. Sci.	*Proceedings of the Nova Scotian Institute of Science.* Halifax, No Scotia.
**"Relations between Solar and Terrestrial Phenomena." Sixth Report, I.C.S.U.* (1948)	*Sixth Report of the Commission for the Study of Relatio between Solar and Terrestrial Phenomena* (1948). Internation Council of Scientific Unions, Gonville and Caius Colleg Cambridge.
Rev. Geofis.	*Revista de Geofisica.* Instituto Nacional de Geofisica, Rios Rosas Madrid.
Teleteknik	*Teleteknik.* Valkendorfsgade 9[1], Copenhagen.
**Zavodskaya Lab.*	*Zavodskaya Laboratoriya.* [Abstracted by *Photographic Abstracts*

NEW JOURNAL

Indian J. Met. Geophys.	*Indian Journal of Meteorology and Geophysics.* India Meteorologic Department. Director-General of Observatories, Lodi Roa New Delhi. Quarterly subscription R. 2–6 or 4sh. per copy.

ABSTRACT JOURNALS

Brookhaven Guide to Russian Literature	*Guide to Russian Scientific Periodical Literature.* Information an Publications Division, Brookhaven National Laboratory, Upto Long Island, New York.
Meteorological Abstracts	*Meteorological Abstracts and Bibliography.* American Meteor logical Society, 5 Joy Street, Boston 8, Massachusetts.

ORIGINAL ARTICLES

It is regretted that the articles from which abstracts are made cannot be sent out on loan. Application should be made to appropriate lending libraries or to the publisher of the Journal concerned; publishers' addresses, where known, are given in the "List of Journals" published with the January Number of Vol. 53 (1950), or in the supplementary lists published subsequently.

ERRATA

Abstr. 5077, line 2: *for* Aryes, H. *read* Ayres, H.
Abstr. 5633, line 1: *for* "Stepping" *read* "Stopping."
Abstr. 5964, 6183, 6188, 6428, 6433, 6442, journal reference: *for* April 15 *read* March 15.

Publications

OF

THE PHYSICAL SOCIETY

THE Physical Society is concerned with the propagation of Physical Science, and membership is open to all who are interested in Physics.

A full list of journals and other publications of the Physical Society may be obtained from the Society's offices. A selection is given below.

PROCEEDINGS OF THE PHYSICAL SOCIETY

Section A—subjects connected with microscopic physics.

Section B—subjects connected with macroscopic physics.

Each section appears monthly

REPORTS ON PROGRESS IN PHYSICS

A comprehensive annual review by specialist authors.

HANDBOOK OF THE ANNUAL EXHIBITION OF SCIENTIFIC INSTRUMENTS AND APPARATUS

METEOROLOGICAL FACTORS IN RADIO-WAVE PROPAGATION

Report of a Conference held jointly by the Physical Society and the Royal Meteorological Society, 1946.

REPORT OF INTERNATIONAL CONFERENCE ON FUNDAMENTAL PARTICLES (Vol. I) and LOW TEMPERATURES (Vol. II), Cambridge, 1946

THE EMISSION SPECTRA OF THE NIGHT SKY AND AURORAE

Papers read at an International Conference held under the auspices of the Gassiot Committee, London, July, 1947.

THE STRENGTH OF SOLIDS

Report of Conference, Bristol, July, 1947.

RESONANT ABSORBERS AND REVERBERATION

Report of the 1947 Summer Symposium of the Acoustics Group of the Physical Society.

NOISE AND SOUND TRANSMISSION

Report of the 1948 Summer Symposium of the Acoustics Group of the Physical Society.

Prices will be supplied on application.

Reduced prices are allowed to members of the Physical Society on all the above publications.

THE PHYSICAL SOCIETY,

1 Lowther Gardens, Prince Consort Road, London, S.W.7.

MATHEMATICS 51

513

2116. The differential formulae of spherical polygonometry and their applications to astronomy. C. Kozieł. *Bull. Int. Acad. Polonaise Sci. Lett., A Nos* 1–4) 1–16 (1949).

513.76

2117. Some conformal transformations involving elliptic functions. C. Darwin. *Phil. Mag.*, **41**, 1–10 *Jan.*, 1950).

Conformal transformations are given which are suitable for the discussion of the space outside a finned rectangle. These include figures such as rectangle, cross, 3-sided box, form like the letter H, "windmill," and the transformation could be applied to any rectangle with 4 fins of any lengths at its corners, each of them in either of 2 directions. The transformations convert the outer space into the inside of a rectangle, which can then be transformed back into the outside of a circle, with the same point at infinity as the original space. By a generalization of a special case of this transformation another is given, whereby an irregular star, composed of any number of rays of any lengths and at any angles branching out from a centre, can be transformed into a circle. This includes, as a simple example, a "dihedral" of 2 equal arms at any angle. A.

517.93

2118. Harmonic and subharmonic response for the Duffing equation $\ddot{x} + \alpha x + \beta x^3 = F \cos \omega t$ ($\alpha > 0$). M. E. Levenson. *J. Appl. Phys.*, **20**, 1045–51 (*Nov.*, 1949).

517.93

2119. A note on a generalized Van der Pol equation. W. Nijenhuis. *Philips Res. Rep.*, **4**, 401–6 (*Dec.*, 1949).

The problem of solving the asymmetrical Van der Pol equation, $\ddot{v} - \varepsilon(1 - 2\beta v - v^2)\dot{v} + v = 0$, is equivalent to that of solving an ordinary Van der Pol equation ($\beta = 0$) with a constant right-hand side. For large values of ε and β, a simple approximation of the limit cycle is found from which it follows that the ratio of the maximal ordinates of $v(t)$ in the positive and negative directions cannot exceed 3 : 1. A.

517.946

2120. A technique for rendering approximate solutions to physical problems uniformly valid. M. J. Lighthill. *Phil. Mag.*, **40**, 1179–201 (*Dec.*, 1949).

The technique applies to non-linear problems, especially those involving a non-linear partial differential equation for which approximate linearization is permissible everywhere except in a limited region. The independent variable is transformed progressively with successive approximations to the solution; only one step is necessary if a first approximation valid uniformly is to be obtained. Various problems are considered including the "spread" of a progressive wave at infinity. L. S. Goddard

518.5

2121. Proceedings of a symposium on large-scale digital calculating machinery. *Ann. Comput. Lab. Harv. Univ.*, **16**, 302 *pp.* (1948).

A programme of the symposium (Jan. 7–10, 1947) and a list of members constitute the first two chapters. The remaining chapters are as follows: Existing calculating machines; The logic of large-scale calculating machinery; Storage devices; Numerical methods and suggested problems for solution; Sequencing, coding and problem preparation; Input and output devices; Conclusions and open discussion. INDEX AERONAUTICUS

518.5 : 532.5 : 621.317.729

2122. Apparatus for the experimental solution of hydrodynamic problems with the method of electrical analogy. A. Dolcetta. *Energia Elett.*, **26**, 461–8 (*Aug.*, 1949) *In Italian.*

After recalling briefly the basis of the method of analogy for the study of harmonic fields, an apparatus built for research on the motion of water through porous media is described. It consists of an electrolytic tank $60 \times 60 \times 16$ cm in volume. The voltage is 10–15 V and sonic frequencies are used to reduce polarization effects and interference from the mains. The sensitivity near the electrodes is increased by the elimination from the null indicator of the off-balance signal generated by electrode-electrolyte capacitance. The results are given of two preliminary experiments carried out with the object of developing a suitable technique. F. J. Miranda (R)

518.5 : 621.318.572

2123. The Bell computer, model VI. E. G. Andrews. *Elect. Engng, N.Y.*, **68**, 751–6 (*Sept.*, 1949).

A relay type computer, remotely controlled by teleprinter, using 3, 6 or 10 (decimal) digit numbers with floating decimal point (10^{-19} — 10^{+19}); designed to deal mainly with matrix, integral, differential and simultaneous equations. The arithmetical calculator can add, subtract, multiply, divide and extract square roots: there are two independent storage tapes. A central routine control directs the computation, and 200 self-contained subroutines which can be set up as required are available. No details of operating times are given. A. O. Stanesby (R)

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.312

2124. The differential correction of orbits. J. G. Porter. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 4) 409–20 (1949).

Deals with the differential correction of the orbits of comets and minor planets in terms of certain elements and other constants. The formulae used are related to those of the Tietjen method, but are adapted for calculating machines. In the case of a comet which has been observed at a previous return,

it is possible to link the two apparitions, thus obtaining a more reliable value of the correction to the mean motion. The resulting equations contain no more than 3 unknowns and afford a simple solution to the problem. An alternative to the usual least-squares solution is suggested. A.

521.312

2125. A modification of the perturbations-of-elements method. G. MERTON. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 4) 421–35 (1949).

The division of the orbit of a comet or minor planet, into an integral number of parts, permits the construction of special tables which facilitate the calculation of the special perturbations, by the planets, in terms of the variations of the usual ecliptic elements. Such tables have been published, but the approximate methods usually employed with them are not, it is argued, accurate enough to be generally suitable for the predictions of the returns of periodic comets. A rigorous method, treating the time element as perturbed and the mean anomaly as the independent variable, is here derived, very simply, for use with these tables or with the new ones proposed. And the integration of the perturbations of the mean anomaly, involving a double integration, is replaced by a single integration of the perturbed time interval. A.

522.21

2126. Tower telescopes. I. H. GOLLNOW. *Naturwissenschaften*, **36** (*No.* 6) 175–82 (1949) *In German.*

Comprehensive treatment of the experience gained in instrumental astrophysics during 40 years of solar tower work. The various optical and mechanical designs are confronted, particularly those of the two instruments at Mount Wilson (1906–12), Utrecht (1922), Potsdam (Einstein–Tower, 1920–24), Tokio, Arcetri (1926) and Canberra (1928). An extensive table gives full numerical details about the construction of the coelostats, telescopes, and various spectroscopic outfits. A. BEER

522.21

2127. Tower telescopes. II. H. GOLLNOW. *Naturwissenschaften*, **36** (*No.* 7) 213–17 (1949) *In German.*

The new constructional developments are illustrated by comparisons between the tower telescopes at the University Observatory, Oxford, the Californian Astrophysical Observatory, Pasadena, the two telescopes of the McMath–Hulbert Observatory, Michigan, the 3 new instruments of the Fraunhofer Institut, Germany (Wendelstein 1922 and Schauinsland 1943 and 1944), the large solar tower at Göttingen (1944) and the nearly finished Dunsink–Dublin tower (1950). Particular attention is drawn to 4 different technical solutions for effecting the required independent movements of the various parts. A. BEER

523.12

2128. Creation of matter in the universe. T. GOLD. Letter in *Nature, Lond.*, **164,** 1006–7 (*Dec.* 10, 1949).

Jordan's theory [Abstr. 654 (1950)] involving the conservation of energy is contrasted with the steady-state theories of Hoyle, Bondi and Gold [Abstr. 3674, 3754 (1949)]. R. A. NEWING

523.

2129. Search for an atmosphere in the vicinity of th moon. B. LYOT AND A. DOLLFUS. *C.R. Acad. Sc Paris*, **229,** 1277–80 (*Dec.* 14, 1949) *In French.*

An attempt to measure the twilight effect of hypothetical lunar atmosphere at quadrature described. To reduce the intensity of light scattere by the earth's atmosphere and the optical system, th 20 cm coronagraph at the Pic du Midi was use photographic comparison between the ashen ligh and the intensity just outside the lunar disc at the tip of the terminator being made with a yellow filter The distribution of photographic intensity near th limb was determined microphotometrically, an shown to be very different from that expected for th twilight effect; it can be attributed to scattering irradiation and Eberhard effects. From the Rayleigh scattering formula, it is estimated that a lunar atmo sphere of surface density $> 10^{-8}$ that of the terrestria atmosphere could have been easily detected.

M. W. OVENDEN

523.42

2130. On the constitution of Venus. K. E. BULLEN *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 4) 457–61 (1949).

The constitution of Venus is discussed in the light of the density-pressure hypothesis stated by Ramsey [Abstr. 4295 (1949)]. It is shown that on this theory, an increase in the precision of observations of the diameter of Venus may lead to a useful test on the question of the chemical homogeneity of the earth's mantle. The bearing of the writer's compressibility-pressure hypothesis on the density distribution in Venus is discussed. Values of the density and pressure in Venus are also given on the older hypothesis that the earth's mantle and core are composed of chemically distinct materials. A.

523.51

2131. The study of meteor velocities. J. G. PORTER. *J. Brit. Astr. Ass.*, **60,** 1–18 (*Dec.*, 1949).

A survey of methods of measurement and conclusions of the statistical analysis of results.

M. W. OVENDEN

523.51 : 621.396.9

2132. A radio echo method for the measurement of the heights of the reflecting points of meteor trails. J. A. CLEGG AND I. A. DAVIDSON. *Phil. Mag.*, **41,** 77–85 (*Jan.*, 1950).

Describes a method of finding the heights of occurrence of meteor trails from the radio echoes obtained by broadside reflection on a frequency of 60 Mc/s. The range of the reflecting point from the observing station is measured by radio pulse technique and its elevation is determined by comparison of the signals received in 2 aerials mounted at different heights above a horizontal reflecting surface. Results obtained by this method during the Quadrantid shower of 1949 agree well with those of visual observers. A.

523.53

2133. Radio echo and visual observation of the Bielid meteor streams in 1948. J. A. CLEGG, A. C. B. LOVELL AND J. P. M. PRENTICE. *J. Brit. Astr. Ass.*, **60,** 25–7 (*Dec.*, 1949).

Details of observations, including radar velocity determinations. M. W. OVENDEN

523.53

2134. The 1948 return of Bečvář's meteor stream. A. Clegg, A. C. B. Lovell and J. P. M. Prentice. *J. Brit. Astr. Ass.*, **60**, 27–31 (*Dec.*, 1949).

Radar and visual observations are compared with those of the 1947 return. M. W. OVENDEN

523.63

2135. The influence of Neptune on the motion of the comet Wolf I. M. Kamieński. *Bull. Int. Acad. Polonaise Sci. Lett., A* (*Nos* 1–4) 51–2 (1949).

523.72

2136. The solar illumination constant and its most probable value. V. V. Sharonov. *Izv. Akad. Nauk, SSSR, Otdel. Tekh. Nauk* (*No.* 9) 1284–96 (*Sept.*, 1949) *In Russian.*

The solar illumination constant is the visual brightness (in photometric units) produced on a plane perp. to the incident rays, at the distance of 1 a.u. The practice of measuring this constant and the inherent difficulties of this problem are described in detail, including the methods for obtaining the extra-atmospheric value. The complexities of the task are illustrated by the very full historical collection of values obtained since 1725 and the enormous deviations between them. A method for using the thermal solar constant for determining the light constant is suggested, similar to Siedentopf and Reeger's method [*Met. Z.*, **61** (*No.* 4) 114–17 (1944)]. The value recommended as most reliable from all aspects is 13·5 phot, corresponding to a luminous flux of $2{\cdot}99 \times 10^{27}$ candles. B. F. KRAUS

523.72

2137. Solar ultra-radiation on December 24 and 25, 1948. A. Ehmert. *Z. Naturforsch.*, **4a**, 559–60 (*Oct.*, 1949) *In German.*

A note (with diagram) of the well-correlated time variations of solar (far u.v. + ionic) radiation, derived from c.r. coincidence-counter measures, and geomagnetic field strength observed on December 25, 1948, and associated with C.M.P. of an active sunspot group. D. R. BARBER

523.72 : 537.591

2138. Cosmic radiation from the sun. J. Zirkler. *Z. Naturforsch.*, **4a**, 394 (*Aug.*, 1949) *In German.*

Dates of observations of increases of cosmic radiation intensity in 1941 are tabulated, and compared with the observations of Ehmert [Abstr. 418 (1949)] and with observed magnetic storms in the light of the 27 d recurrence tendency. M. W. OVENDEN

523.72 : 537.591.5

Intense solar emission of cosmic rays. *See Abstr.* 2556

523.73

2139. On the solar electric field engendered by the rotation of the sun in its magnetic field. V. C. A. Ferraro and H. W. Unthank. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 4) 462–70 (1949).

The rotation of the sun in its magnetic field gives rise to an electrostatic field, the equipotential surfaces of which are the surfaces of revolution obtained by rotating the magnetic lines of force around the axis. The same is true for any rotating star possessing a magnetic field. If the angular velocity of the star is not constant, then it seems likely to be uniform over these same equipotential surfaces. This law of isorotation must hold for the solar atmosphere and corona as well, and may extend to the surrounding interstellar space. Also the resulting surface and space charges and the magnetic field due to their motion around the axis are negligible, in apparent contradiction with certain conclusions of Davis [Abstr. 11 (1948)]. A.

523.73

2140. On the appearance of vortex movements in the sun. J. Tuominen. *Proc. K. Ned. Akad. Wet.*, **52** (*No.* 7) 747–59 (1949).

The eqs. of motion of the rotating sun have been investigated to find movements deviating from rotational symmetry, which might occur owing to differential rotation. The problem was first limited to stationary movements of small angular diameter, which were found to occur in a thin layer only. They are stationary in a co-ord. system fixed in space, and are vibrations outwards and inwards and back and forth in the co-ord. system rotating with the sun. The radial component is the strongest, the *N–S* component the weakest. A.

523.75

2141. The problem of the anomalous distribution of densities in the chromosphere. I. S. Shklovskiĭ. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 5) 829–31 (1949) *In Russian.*

523.75

2142. On the ionization of the chromosphere protuberances. I. S. Shklovskiĭ. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 6) 1009–11 (1949) *In Russian.*

523.75

2143. The heating of the solar corona and chromosphere. E. Schatzman. *Ann. Astrophys*, **12**, 203–18 (*July–Sept.*, 1949).

According to this theory the chromosphere is heated by dissipation of energy of shock waves. The temp. increases extremely rapidly in the outer chromosphere and reaches $1{\cdot}24 \times 10^6$ degrees at 0·056 solar radius above the limb. Further out the high conductivity of the electron gas in the corona is sufficient to maintain it almost isothermal. The theoretical distribution of densities and temps. seems to agree with the observations. A.

523.77

2144. Observations of the solar corona at Climax, 1944–1946. W. O. Roberts and A. H. Shapley. *Rep. Cent. Radio Prop. Lab.* (*U.S. Bur. Stand.*) (*Nos* 1–4) 33 *pp.* (1948).

Intensities of the λλ5303, 6374 and 6704 coronal emission lines are tabulated for 5° intervals round the solar limb on an arbitrary scale. M. W. OVENDEN

523.77 : 535.333

Carbon dioxide in the infra-red solar spectrum. *See Abstr.* 2331

523.77 : 535.417

2145. High-resolution interferometry of the solar spectrum. P. J. Treanor. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 4) 389–408 (1949).

The possibility of obtaining resolving power of the order of 10^6 by interferometric means is investigated. The chief difficulty in obtaining a high-resolution interferometric analysis of a continuous spectrum

broken by absorption lines lies in the fact that high primary monochromatization is required to present the interferometer with a range of spectrum small enough to be analysed without overlap of orders. This consideration sets a limit to the factor of gain obtainable by interference methods, and defines somewhat narrowly the correct conditions of employment of the spectroscope and interferometer. An experimental arrangement is described, designed to satisfy these conditions. A short etalon of high reflectivity is placed behind the spectrum of the sun. Recollimated light from this spectrum is analysed by the etalon, and produces an interference pattern in a plane conjugate to that of the spectrum, in the focal plane of a camera. This pattern consists of a system of circular heterochromatic channels, and within these channels a system of monochromatic absorption fringes appears. These absorption fringes are interferometric spectra of the solar absorption lines, and their definition is determined by the resolving power of the etalon only. The sharpness of the fringes makes possible wavelength measurements of high precision. Measurements in the *D* region show that the probable error for a single plate will be about 0·001 Å. The interference photographs display continuously, without overlap of orders, an interferometric spectrum exceeding many times the range of the etalon used. This feature, combined with the resolution, makes the method suitable for the photometric determination of line contours. A.

523.774

2146. Note on methane in the infra-red solar spectrum. R. R. McMath, O. C. Mohler, A. K. Pierce and L. Goldberg. Letter in *Phys. Rev.*, **76**, 1533–4 (*Nov.* 15, 1949).

Combination bands of CH_4 between 2·15 μ and 2·45 μ observed in the laboratory have been detected in solar spectra. M. W. Ovenden

523.774

2147. Variations of certain Swan bands of carbon from the centre to the limb of the sun's disc. C. Pecker and J.-C. Pecker. *Ann. Astrophys.*, **12**, 197–202 (*July–Sept.*, 1949) *In French.*

Continuing his earlier researches into the behaviour of CH-lines [Abstr. 3019 (1947), 3695 (1949)] the author shows that the two important C lines at 5 104 and 5 132 also confirm his previous results. In order to bring about full agreement between observation and theory, Redman's correction factors [Abstr. 44 (1944)] are successfully introduced. A. BEER

523.82

2148. Blue and red magnitudes in the Auriga region. I. Preliminary note. O. Eklöf. *Ark. Astr.* **1** (*No.* 8) 77–89 (1949).

523.82 : 612.84

The scintillation of stars. *See Abstr.* 2833

523.83

2149. Preferential motion of 454 stars. M. C. Ballario and A. Colacevich. *Mem. Soc. Astr. Ital.*, **20** (*No.* 4) 253–74 (1949) *In Italian.*

The space stellar motions of 454 stars of apparent magnitude $\leqslant 5{\cdot}50$ with direction almost in agreement with that of Ursae Majoris is considered. A.

523.8

2150. On the axial rotation of the brighter O a B stars. A. Slettebak. *Astrophys. J.*, **110**, 499–5 (*Nov.*, 1949).

Rotational velocities have been determined for total of 123 stars, comprising the brighter *O*, *B2–B* and *B2e–B5e* stars. The method involves the com parison of the observed line contours of He I 4 02 with theoretical line contours computed by means a graphical method for various equatorial rotation velocities. An attempt has been made to take int account the effects of limb darkening, gravity darken ing and differential rotation on the computed lin contours. Values of $v \sin i$ in excess of 400 km/s wer found for several stars in each of the 3 groups studied The *Be* stars have the most rapid axial rotatio observed for any class of stars; their mean rotationa velocity was found to be at least 150 km/s $>$ th mean rotational velocity for the corresponding grou of *B* stars. Among the *Be* stars the shell stars hav the largest rotational velocities and the pole-on star the smallest, which is interpreted as an inclination effect. The observed rotation in the *Be* stars i somewhat $<$ would be expected under the assumption that these stars may be represented by Roche model at the point of rotational instability. It is suggested that radiation pressure and turbulence may be responsible for the discrepancy. Rapid rotation appears to be principally confined to stars on or slightly above the main sequence. A

523.841.1

2151. On the spectrum of Nova Scuti 1949 C. Fehrenbach. *C.R. Acad. Sci., Paris*, **229** 1059–60 (*Nov.* 21, 1949) *In French.*

523.841.11

2152. The supernovae of the galactic system D. Wattenberg. *Z. Naturforsch.*, **4a**, 228–38 (*June*, 1949) *In German.*

Critical survey of recent research on supernovae by Baade, Zwicky, Minkowski and Jordan. Statistical considerations about the frequency of their occurrence, absolute magnitude, light curves and discussions on the nature of their origin are followed by notes on the Chinese Nova of 1054 and the Crab nebula in Taurus, the Tychonian Nova in Cassiopeia of 1572, Kepler's Nova in Ophiuchus of 1604, and on correlations between planetary nebulae and supernovae.

A. BEER

523.841.11

2153. The Zeeman effect n astrophysical spectra. II. The emission spectra of novae. C. E. R. Bruce. *Rep. Brit. Elect. Res. Ass.* (*Ref. No. L/T218*) 13 *pp.* (1949).

Develops the suggestion [Abstr. 5895 (1949)] that the broadening of the lines in the spectra of novae may be accounted for by Zeeman effect, and not Doppler effect, which last is usually regarded as the cause. It is shown that in the early stages of several well-known novae the law connecting line width and wavelength is in fact that appropriate to the Zeeman effect, and cannot be explained by the Doppler effect. A.

523.841.37

2154. Period and photographic light curve of the Cepheid *BY* Cassiopiea. W. H. DIRKS AND G. DE VAUCOULEURS. *Ann. Astrophys.*, **12**, 219–26 (*July–Sept.*, 1949) *In French.*

523.851

2155. The structure of stellar associations. G. A. GURZADYAN. *Dokl. Akad. Nauk, SSSR* **64** (*No.* 6) 787–9 (1949) *In Russian.*

523.851

2156. Dynamics of stellar associations. G. A. GURZADYAN. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 2) 145–8 (1949) *In Russian.*

523.852.22

2157. Recent results and state of planetary nebula research. I. K. WURM. *Naturwissenschaften*, **36** (*No.* 9) 273–9 (1949) *In German.*

The present conditions of our insight into the physics of nebular envelopes are critically reviewed, mainly on the basis of work done in the past 10 years and including the author's own (partly unpublished) contributions. The given analysis of the nebular spectra deals with the nebular continuum, the electron temps., the high intensities of the forbidden transitions, the electron densities, the classification of the variety of observed spectra and with the theory of radiation transfer. A. BEER

523.854

2158. The rotation of the Milky Way and the theory of the high-velocity stars. P. TEN BRUGGENCATE. *Nachr. Wiss. Göttingen* (*No.* 1) 4–11 (1947) *In German.*

Oort's theory of the high-velocity stars is applied to the assumption that in the neighbourhood of the sun circular orbits of the stars predominate. The potential of such a model is given, and the constants of rotation and velocity of escape, as well as the ratio of the central to the total mass are calculated. A substantial decrease in the accepted dimensions of the stellar system is suggested. A. BEER

523.854.12

2159. On selective absorption by interstellar clouds. E. SCHATZMAN. *Ann. Astrophys.*, **12**, 227–8 (*July–Sept.*, 1949) *In French.*

This preliminary investigation utilizes elementary statistical considerations, assumes for simplicity the interstellar clouds to be all spherical, of the same dimensions and distributed in space at random, and also makes use of Stebbins' and Whitford's work [*Astrophys. J.*, **4**, 17 (1939)]. The results are 7·2 for the number of clouds traversed by a light ray within 1 000 parsec, and 0·04 magnitudes for the reddening effect per cloud. This is in general agreement with Spitzer's results [Abstr. 1647 (1949)] and does not contradict Ambarzumian's and Gordeladse's statistical studies [*Bull. Abastumani Astrophys. Obs.*, **2**, 37 (1937) and **4**, 17 (1939)]. It is thus suggested that the distribution of these clouds of interstellar matter permits the interpretation of the fluctuations of the reddening of the *B* stars. A. BEER

523.855

2160. On the distribution of light-intensity and colour in the spiral nebula Messier 63. B. LINDBLAD AND J. DELHAYE. *Stockholms Obs. Ann.*, **15** (*No.* 9) 26 *pp.* (1949).

These distributions have been studied on plates taken with the Crossley reflector of the Lick Observatory. The colour-index on the international scale and the magnitudes per square minute of arc have been determined on plates taken on the 40 cm astrograph of the Stockholm Observatory. The characteristic G-shaped absorption lane has been studied in detail, and seems to admit a determination of the direction of tilt with considerable certainty. Available data concerning the spectrographic rotation appear to confirm earlier conclusions that the spiral arms open up in the direction of rotation. A.

523.873

2161. Line-intensities in stars of type *G5* to *K5*. A. D. THACKERAY. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 4) 436–56 (1949).

523.873

2162. On the spectra of the carbon stars. R. BOUIGUE AND C. FEHRENBACH. *C.R. Acad. Sci., Paris*, **229**, 1207 (*Dec.* 5, 1949) *In French.*

Results from a recomputation of transition probabilities for the CN molecule (necessitated by the discovery of a new i.r. band at 10 933 Å) are in good agreement with observed data for 4 C stars. The temp. deduced for these stars (2 300°) agrees with that found from the Swan bands of C_2 (2 000°), but the observed relative intensities of the +4 and +5 band sequences still differ strongly from theoretical values. Work is being continued on this point. D. L. EDWARDS

523.873 : 535.333

2163. Bands of the molecule $C^{13}N^{14}$ in spectra of carbon stars (red system $^2\Pi$–$^2\Sigma$). G. A. SHAĬN AND V. F. GAZE. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 1) 661–4 (1949) *In Russian.*

An attempt to prove the existence of bands of the heavy molecule $C^{13}N^{14}$ in spectra of carbon stars and to identify some previously observed unknown spectral data as these bands. F. LACHMAN

523.877

2164. On equations of transfer of radiation in stellar atmospheres. L. M. BIBERMAN. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 3) 443–5 (1949) *In Russian.*

An integro-differential equation is developed for the intensity of emission of frequency ν as function of co-ordinates and direction, taking frequency changes into account. An integral equation for the concentration of excited atoms is established from which the number of atoms in a given direction is found. This replaces expressions for stream of photons as concentration gradient. Changes of photon frequency are of order of width of spectral line, hence this method is useful for problems on shape of stellar spectral lines. J. JACOBS

523.877

2165. Anharmonic pulsations of two particular models. C. PRASAD. *Astrophys. J.*, **110**, 375–81 (*Nov.*, 1949).

Anharmonic pulsations of the homogeneous model and the model in which the density varies inversely as the square of the distance from the centre are considered. It is found that the overtones are absent in the homogeneous model and the skewness of the radial-velocity-curve is small. In the second model the effects of the overtones are alternately positive and

negative and rapidly decreasing; and the total displacement gives a slight skewness in the direction opposite to that observed. This, combined with the result of a previous paper that a large skewness is obtained for the standard model, shows that the shape of the velocity-curve depends to a large extent on the model. A.

523.877

2166. Second supplement to the Mount Wilson catalogue and bibliography of stars of classes B and A whose spectra have bright hydrogen lines. P. W. MERRILL AND C. G. BURWELL. *Astrophys. J.*, **110**, 387–419 (*Nov.*, 1949).

523.877

2167. Curves of growth and line contours. A. UNSÖLD AND O. STRUVE. *Astrophys. J.*, **110**, 455–62 (*Nov.*, 1949).

The curve of growth and the line contours of δ Canis Majoris (cF8) are explained by assuming large-scale turbulence with $\Xi = 22$ km/s or—less probably—rotation with an equatorial velocity $v \sin i \simeq 30$ km/s. Moreover, the intensity of the continuous background in the range 4 000–4 100 Å may be depressed by the crowding of lines to 70% of its original intensity. It is also possible that on top of a normal reversing layer having a turbulent velocity of the order of 5–10 km/s there is an optically thin layer produced by a field of interlacing prominences which may be described by a large turbulent velocity. The differences found between the curves of growth for neutral and those for ionized atoms, as well as low-and-high-excitation states, in solar-type stars can be interpreted by assuming that the turbulent velocity ξ increases with decreasing pressure, following the law of continuity. The remaining inconsistencies are traced to a probable "coupling" in the simultaneous determination of turbulent velocity and excitation temp. Reasons are given for the conclusion that the solar excitation temps. are closer to 5 400° or 5 700° than to 4 800°K. The use of "solar transition probabilities" is considered critically. The meaning of effective turbulent velocities is discussed. Errors resulting from the use of a single curve of growth for an entire stellar spectrum are estimated not to exceed $\Delta \log NH = \pm 0{\cdot}47$ if suitable mean values are used. The aerodynamic aspects of turbulence in stellar atmospheres are reviewed, following recent developments of the theory of turbulence. A.

523.877

2168. Stellar spectra and colors in a clear region in Cygnus. J. J. NASSAU AND D. A. MACRAE. *Astrophys. J.*, **110**, 478–97 (*Nov.*, 1949).

Spectral types, photographic magnitudes and photored coloured indices of 1 237 stars are given for all stars brighter than photographic mag. 12·0 within a circular field 3·7° in diameter, centred at $\alpha = 20^h00^m$, $\delta = +38{\cdot}0°$ (1950). A.

523.877 : 539.155.2

2169. The intensities of isotopic carbon bands in the spectra of twenty-one *R*-type stars. A. MCKELLAR. *Publ. Dom. Astrophys. Obs. Ottawa*, **7** (*No.* 26) 395–414 (1949).

A historical résumé is given of investigations of the abundance ratio of the C isotopes (C^{12}/C^{13}). It is noted that the C^{12}/C^{13} abundance ratio in terrestrial and meteoritic carbon is about 90. In nearly all stellar spectra of types *R* and *N*, the bands of the C_2 Swan system involving C^{13} appear with considerable strength. Observational data obtained at Victoria, consisting of 63 single-prism spectrograms of 21 *R*-type stars, are described. The techniques used are outlined. The problem of obtaining the relative abundance of C^{12} to C^{13} from the intensities of the bands is discussed, and the values obtained are listed. For 3 stars there is very little, if any, trace of C^{13}, the min. values of the C^{12}/C^{13} ratio being 30, 60 and 70. The remaining 12 stars are found to exhibit an unexpected and remarkably constant C^{12}/C^{13} abundance ratio, the mean value being 3·4. The results are taken to indicate that 2 groups may be distinguished among the *R*-type stars, one characterized by a C^{12}/C^{13} abundance ratio of the order of 50 or more and the other with a ratio about 3. Two possible explanations of the above result are outlined. The first explanation arises from recent work on the origin of the chemical elements by Klein, Beskow and Treffenberg [Abstr. 414 (1947)] whose different "models" yield different abundance ratios of C^{12}/C^{13}. The second, resulting from a discussion with Fermi, explains the two groups of stars in terms of the C–N cycle initiation. A.

523.877 : 539.185

A new solution of Milne's problem for the transfer of radiation. *See Abstr.* 2699

525.11 : 526.15

2170. Form and mass of the earth. J. ZAHRADNÍČEK. *Publ. Fac. Sci. Univ. Masaryk* (*No.* 287) 16 *pp.* (1947) *In Czech.*

Taking into consideration terms of the second order, the author first computes the flattening of the earth from Clairaut's equation, using for the great axis the value given by Hayford and for the gravitational acceleration the value accepted by U.G.G.I. in Stockholm (1930). The computed value $\varepsilon = 1/297{\cdot}3$ differs by only $\frac{1}{10}\%$ from the value given by Hayford. Accepting as the most probable value for the Newton gravitational constant $\chi = (6{\cdot}667 \pm 0{\cdot}005)\ 10^{-8}$ abs unit (obtained as the mean of the measurements made by 6 different authors from 1889 to 1927), he finally obtains for the mass of the earth $M = (5{\cdot}979 \pm 0{\cdot}004)\ 10^{27}\ g$, a value different from that accepted at the meeting of U.G.G.I. in Madrid (1924). APPLIED MECHANICS REVIEWS

525.3

2171. Influence of oscillations of the ocean level produced by the movement of the earth's pole, on the latter movement. E. P. FEDOROV. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 4) 647–51 (1949) *In Russian.*

525.61

2172. The tides in oceans on a rotating globe. V. G. R. GOLDSBROUGH. *Proc. Roy. Soc. A*, **200**, 191–200 (*Jan.* 6, 1950).

A method is presented of solving the dynamical equations of the tides on a rotating globe with boundaries along meridians. The method makes it possible to write down explicitly in algebraic form the terms of the double series in which the formula for the tide height is expressed. For the case of the luni-solar tide with a restricted law of depth the

oeffs. are worked out and certain critical depths valuated. A.

526.918

173. Photogrammetric errors from camera lens ecentering. P. D. CARMAN. *J. Opt. Soc. Amer.*, 9, 951–4 (*Nov.*, 1949).

A mathematical study has been made of the dis- ortion introduced by a thin prism associated with a erfect lens of 6 in focal length covering a 9×9 in egative. The position of the principal point for min. distortion is found to lie away from the two currently used. A.

526.92 : 621.396.9

2174. Geodetic measurements by radar. D. J. HALLIDAY. Letter in *Nature, Lond.*, **164**, 1005–6 (*Dec.* 10, 1949).

Publication of results obtained in Italy during 1945 using two fixed ground stations and an aircraft flying in a circular arc centred on one station. The accuracy obtained from two sets of experiments was one part in 25 000 and one part in 30 000 and the major source of error was uncertainty in the variation of refractive index over the radar path.

J. M. HOUGH

529.7

2175. Conversion of mean solar time to mean sidereal time. J. HERS. Letter in *Nature, Lond.*, **164**, 841 (*Nov.* 12, 1949).

It is suggested that measures of both time systems may be obtained from one standard frequency quartz oscillator, using a simple electronic frequency divider to obtain an accuracy of about $8 \cdot 5$ in 10^7, small residual errors being corrected by a mechanically-operated phase shifter to give an accuracy of 1 in 10^{12}. M. W. OVENDEN

529.786 : 621.396.611.21

2176. Quartz clocks. L. DUQUEROIX. *Ann. Franç. Chronom.*, **3** (*No.* 2) 145–56 (1949) *In French.*

The basic principles of quartz clocks and their advantages are described. Electronic circuits for various types of frequency dividers are shown and details of a new quartz frequency divider are given. Since the operation of the latter is dependent on temp., it is preferably thermostatically controlled. The stability of the oscillations is stated to be 10^{-5} without thermostatic control and 10^{-6} and 10^{-7} with simple and with double thermostatic control respectively. R. H. HERZ

PHYSICS 53

FUNDAMENTALS 530.1

530.12

2177. Action as a space co-ordinate. III. YU. B. RUMER. *J. Exp. Theor. Phys., USSR*, **19**, 868–75 (*Oct.*, 1949) *In Russian.*

[See Abstr. 5234 (1949)]. A new form of tensor analysis, adapted to the purposes of 5-optics, is presented, permitting of formulating the spinor equations of physics in covariant form. This obviates the difficulties obstructing the introduction of spinors into non-Euclidean space when conserving classical methods of describing the metric properties of space. In the 5-optics, where the electro-magnetic field appears as a characteristic phenomenon, or consequence, of the metric properties of the 5-space of co-ordinates, time and action, the possibility of a general covariant formulation of the spinor equations becomes a necessity. The author generalizes the consideration to the *n*-dimensional space. The method used is that of Starikin (*ibid.*, **19**, 749 (1949)], which is an application of Hilbert's classical method of determination of metrics in space. B. F. KRAUS

530.12

2178. On circular orbits in Einstein's theory of gravitation. S. A. KAPLAN. Letter in *J. Exp. Theor. Phys., USSR*, **19**, 951–2 (*Oct.*, 1949) *In Russian.*

In Einstein's [*Ann. of Math.*, **40**, 4 (1939)] and Oppenheimer's [*Phys. Rev.*, **55**, 374 (1939)] work it was shown that for some types of physical configurations in Einstein's gravitational field there is a definite upper limit of the density of matter, and a lower limit of the radius of these configurations, distinct from Schwarzschild's singularity. At radii below this limit the configurations become unstable. It is shown that there is also a family of circular orbits in the Einstein, or, more accurately, in the spherically symmetric, stationary, Schwarzschild field possessed of the same characteristics, viz. circular orbits of a radius $<$ a definite limit are gravitationally unstable. In the Schwarzschild field the limiting radius of stability $r = 6\,m$ (where m is mass of central body).

B. F. KRAUS

530.12

2179. On the equations of motion and the matter tensor for systems of finite mass in the general theory of relativity. N. M. PETROVA. *J. Exp. Theor. Phys., USSR*, **19**, 989–99 (*Nov.* 1949) *In Russian.*

The assumption that all bodies must move along geodesic curves, on which Einstein's theory of gravitation was originally based, was later found unnecessary, as the equation of gravitation implicitly contains the equations of motion of gravitating masses. But this negative statement does not help in deriving the equations of motion from the equation of gravitation, because the matter tensor must not be regarded as given and thus has to be determined simultaneously. Fok [*ibid.*, **9**, 375 (1939)] has given an approximate method for calculating the components of the metric tensor $g_{\mu\nu}$ from the equation of gravitation and, under simplifying assumptions, simultaneously determining the matter tensor $T_{\mu\nu}$ inside bodies. The paper presents a second approximation on Fok's principles. B. F. KRAUS

530.12

2180. On the so-called "clock-paradox" of special relativity. E. A. MILNE AND G. J. WHITROW. *Phil. Mag.*, **40**, 1244–9 (*Dec.*, 1949).

According to the paradox, of 2 observers who part company, travel with a large relative speed, and rejoin one another, one will record a shorter lapse of

time than the other. It is shown that this paradox is resolved by kinematic relativity. References to previous discussion are given. The ideas developed are applied briefly to photons. L. S. GODDARD

530.12

2181. The relativity of Galilean frames. E. A. MILNE. *Proc. Roy. Soc. A*, **200**, 219–34 (*Jan.* 6, 1950).

Lorentz transformations are valid only in t-time, whereas classical mechanics employs τ-time. Since classical mechanics is supposed to be valid in any Galilean frame, i.e. any frame in uniform motion relative to the substratum, it becomes important to find the transformations which should replace the Lorentz formulae when passing from one Galilean frame to another. These are determined in the present paper, on a simple convention as to the measurement of time in a Galilean frame. They prove to differ from Lorentz formulae, but have closely allied properties. In particular, they yield Einstein's relative-velocity formulae, which are thus seen to be more general than the Lorentz formulae themselves. A.

530.12 : 534.22

2182. The velocity of sound in general relativity, with a discussion of the problem of the fluid sphere with constant velocity of sound. A. R. CURTIS. *Proc. Roy. Soc. A*, **200**, 248–61 (*Jan.* 6, 1950).

The correct expression for the velocity of sound in general relativity is not obvious, because of ambiguity in defining the density of matter. The velocity is investigated, and it is found that it never becomes $>$ the velocity of light, having the value $3^{-\frac{1}{2}}$ for incompressible matter. This result is used in discussing the Schwarzschild solution for the interior of a fluid sphere. Eddington has already pointed out that this does not correspond to incompressible matter, and a solution for a sphere in which the velocity of sound is constant is sought, particular attention being paid to the special case of an incompressible fluid. No solution in closed form is found, but the equations are discussed in sufficient detail to enable the form of the solutions to be described. The limiting solution when the central pressure becomes infinite is tabulated in the incompressible case, and a number of numerical results are obtained. A.

530.14 : 537.591

2183. Edinburgh conference on fundamental particles. *Nature, Lond.*, **165**, 54–6 (*Jan.* 14, 1950).

Short report of the conference. Experimental results on cosmic rays, and the search for the negative proton and dineutron, were discussed, and theoretical papers on the theory of elementary particles presented.

530.145

2184. The fundamental relations of the new physics. A simple formulation. R. SEELIGER. *Leipzig, J. A. Barth* (1948), 55 *pp. In German.*

In this booklet, which attempts to set forth the fundamental ideas and formulae of quantum theory in the simplest and most logical manner, the treatment differs somewhat from that employed in the standard textbooks. P. M. DAVIDSON

530.145

2185. On invariant permutation relations and the exclusion of supplementary conditions in the quantum theory of the meson field. E. M. LIPMANOV. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 4) 627–30 (1949) *In Russian.*

The components of the vector field cannot be quantized as independent scalars, for an additional relation connects them. Two conditions are sufficient to carry out this quantization uniquely: relativistic invariance of the quantization, canonical permutation relations between independent components. A complex vector meson field is chosen with the classical solutions of the equations of motion. A general Lorenz transformation yields the permutation correlations for the amplitudes of the vector meson field, differing from the canonical form. New operators are introduced which represent emission and absorption of transverse and longitudinal mesons. Dirac's theory of emission is thus applicable.

J. JACOBS

530.145

2186. Erratum: The application of Dyson's methods to meson interactions. P. T. MATTHEWS. Letter in *Phys. Rev.*, **76**, 1419 (*Nov.* 1, 1949).

See Abstr. 719 (1950).

530.145

2187. Space-time approach to quantum electrodynamics. R. P. FEYNMAN. *Phys. Rev.*, **76**, 769–89 (*Sept.* 15, 1949).

[See Abstr. 243 (1950)]. It is shown that a considerable simplification can be attained in writing down matrix elements for complex processes in electrodynamics. Further, a physical point of view is available which permits them to be written down directly for any specific problem. Being simply a restatement of conventional electrodynamics, however, the matrix elements diverge for complex processes. Electrodynamics is modified by altering the interaction of electrons at short distances. All matrix elements are now finite, with the exception of those relating to problems of vacuum polarization. The latter are evaluated in a manner suggested by Pauli and Bethe, which gives finite results for these matrices also. The only effects sensitive to the modification are changes in mass and charge of the electrons. Such changes could not be directly observed. Phenomena directly observable, are insensitive to the details of the modification used (except at extreme energies). For such phenomena, a limit can be taken as the range of the modification goes to zero. The results then agree with those of Schwinger. A complete, unambiguous, and presumably consistent, method is therefore available for the calculation of all processes involving electrons and photons. The simplification in writing the expressions results from an emphasis on the over-all space-time view resulting from a study of the solution of the equations of electrodynamics. The relation of this to the more conventional Hamiltonian point of view is discussed. The methods apply as well to charges obeying the Klein–Gordon equation, and to the various meson theories of nuclear forces. Illustrative examples are given. Although a modification like that used in electrodynamics can make all matrices finite for all of the meson theories, for some of the theories it is no longer true that all directly observable phenomena are insensitive to the details of the modification used. A.

530.145

2188. On realistic field theories and the polarization of the vacuum. D. FELDMAN. *Phys. Rev.*, **76**, 1369–75 (*Nov.* 1, 1949).

The formal prescription for the regularization of divergent expressions in quantum electrodynamics which has been recently suggested by Pauli implies very strongly that these same divergences may be similarly cancelled in a realistic theory wherein one has a mixture of fields in the manner of Pais and Sakata. The Pauli regulator scheme corresponds field-theoretically to a family of spinor fields interacting with a family of neutral vector meson fields; the formalism is mathematically consistent (at least to the second order in the coupling constants) but physically unsound owing to the appearance of imaginary coupling constants. An attempt to remedy this defect by considering the most general mixture which is possible within the framework of ordinary field theory fails. It is concluded that, although the notion of a realistic approach to the theory of elementary particles remains an attractive one, the usual linear field theories are not adequate for this purpose; it is also possible that the perturbation theory is at fault. A.

530.145

2189. On the self-energy of a pseudoscalar meson in interaction with nucleons. E. CORINALDESI AND G. FIELD. *Nuovo Cim.*, **6**, 520–30 (*Nov.* 17, 1949).

The self-energy of a pseudoscalar meson in interaction with nucleons is evaluated in this paper. This is done for the two types of interaction which are possible, i.e. g-coupling (pseudoscalar) and f-coupling (pseudovector). By means of a canonical transformation, first suggested by Dyson, the pseudovector interaction can be shown to be "equivalent" to the pseudoscalar one in certain cases, with a suitably chosen coupling constant. A relation between the self-energies for the case of f-coupling and for the "equivalent" g-coupling is deduced in two ways: (i) by using Dyson's transformation, and (ii) by a direct method. The two results are seen to be different and the reasons for this are discussed. The method of regularization is applied and is seen to make the self-energies finite for both types of coupling. A.

530.145

2190. The application of the Tomonaga–Schwinger theory to the interaction of nucleons with neutral scalar and vector mesons. P. T. MATTHEWS. *Phys. Rev.*, **76**, 1657–74 (*Dec.* 1, 1949).

The Tomonaga–Schwinger theory is applied to the interaction of neutral scalar and vector mesons with nucleons. The Hamiltonians are derived in the interaction representation and virtual effects are transformed away. The meson and nucleon self-energies are calculated. It is shown that they are invariant and, like the electron self-energy, can be transformed away by formal renormalizations of the meson and nucleon masses. All effects are independent of the direction of the general space-like surface in spite of the occurrence in the Hamiltonian of terms explicitly dependent on this direction. A.

530.145

2191. On the interactions of mesons with the electromagnetic field. M. NEUMAN AND W. H. FURRY. *Phys. Rev.*, **76**, 1677–90 (*Dec.* 1, 1949).

By means of the formalism of Duffin and Kemmer there is constructed for mesons interacting with the field a theory that is Lorentz- and gauge-invariant and invariant under charge conjugation. The longitudinal components of the electromagnetic field are eliminated in a covariant manner. The resulting interaction Hamiltonian is analysed into terms corresponding to self-energies and terms describing interactions. By a suitable interpretation of ambiguous expressions, the photon self-energy is shown to vanish. Expressions are found for the polarization of the mesic vacuum by a given e.m. field. In the case of mesons of spin 1, not only the term $\propto$ the original current, but also that $\propto$ its d'Alembertian has an infinite factor. A formal procedure for the unambiguous exclusion of such infinite contributions is suggested. Explicit expressions are found for the self-energies of scalar and vector mesons. These self-energies can be eliminated by renormalization of mass. A.

530.145

2192. Bosons in an electromagnetic field. R. G. MOORHOUSE. *Phys. Rev.*, **76**, 1691–6 (*Dec.* 1, 1949).

The interaction representation for bosons of spin 0 or 1 in an electromagnetic field is given, using β-matrix theory. The gauge-invariance of the scheme is proved. The photon self-energy is shown to be zero, and the meson self-energy is evaluated. The vacuum polarization is evaluated for a particular representation of the β-matrices. A.

530.145 : 535.14

The second radiation constant in Planck's radiation formula. *See Abstr.* 2290

530.145 : 537.122

2193. A note on electron theory. C. J. ELIEZER. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 1) 199–201 (1950).

Equations of motion of an electron which has its charge uniformly spread over the surface of a sphere are shown to lead to self-oscillatory motions for a free electron. Some applications of these equations are briefly indicated. P. M. DAVIDSON

530.145 : 538.3

2194. Higher approximations in the external field for the problem of vacuum polarization. G. KÄLLÉN. *Helv. Phys. Acta*, **22** (*No.* 6) 637–54 (1949).

The convergence and gauge-invariance of the integrals appearing in the higher approximations of vacuum polarization are discussed for the cases of spinor and scalar fields. Only the case of an external electromagnetic field is treated. The more complicated problem of a quantized field is not discussed. As a direct result of the charge symmetry the vacuum expectation values of the current commutators vanish if an odd number of current operators are commuted. Hence the terms $\propto e^{2n+1}$ are identically zero, and in this form the statement is true for both the electrons and the bosons. Of the remaining terms it is shown that only the e^2 and e^4 approximations diverge, but that the still higher terms are both convergent and gauge-invariant. It further appears that, apart from

a numerical factor, which is the same in both approximations (and $= -\frac{1}{2}$), the strongest divergences are the same for the spinor and the scalar fields. The e^2 approximation has previously been treated by Jost and Rayski [Abstr. 6 (1950)], who have shown that the non-gauge-invariant (and divergent) terms compensate each other if one uses a suitable mixture of spinor and scalar fields. In this approximation, however, the logarithmically divergent charge renormalization remains. The conditions of Jost and Rayski are

$$N = 2n \text{ and } \sum_{i=1}^{N} M_i^2 = 2\sum_{i=1}^{n} m_i^2$$

where N and n are the number of scalar and spinor fields respectively and M_i and m_i are the corresponding masses. In the e^4 approximation the first condition alone is sufficient to secure a convergent and gauge-invariant result. A.

530.145.6

2195. Perturbation methods for Dirac radial equations. G. Breit and G. E. Brown. *Phys. Rev.*, **76**, 1307–10 (*Nov.* 1, 1949).

Two methods of calculating perturbation effects for the Dirac electron equation are discussed. The two radial functions enter symmetrically in the main contributions to the effects calculated. The first method is related to the method of the Riccati equation for ordinary second-order differential equations, but differs from it through the use of the ratio of the two radial functions rather than that of the logarithmic derivative of one of them. The second method has some similarity to Milne's phase amplitude method. A.

530.145.6

2196. On infinite relativistic particle matrices. W. Wessel. *Phys. Rev.*, **76**, 1512–19 (*Nov.* 15, 1949).

Besides the known tensors of integral and $\frac{1}{2}$-odd-integral rank (spinors) there exists a new form of relativistic covariant entities with an infinite number of components, discovered in 1944 by Dirac. An especially simple type of them is generated by operations underlying a theory of the electron recently proposed by the present author. This way the representations are obtained immediately in matrix form, the matrices being of an unexpectedly simple type. Half of them have continuous spectra. They permit the setting up of wave equations having always positive energy. A.

530.145.6

2197. Energy bands and wave functions in periodic potentials. H. M. James. *Phys. Rev.*, **76**, 1602–10 (*Dec.* 1, 1949).

In preparation for treatment of the one-dimensional wave equation with perturbed periodic potentials, this paper discusses the case of perfectly periodic potentials. Solutions for the entire range of x are constructed by joining together "cell solutions"—solutions defined for a single period of the potential. Several types of cell solution are discussed. The concept of "self-matching cell solutions" leads to a simple demonstration of the band structure of permitted energy levels. The effective momentum of the particle is defined for energies in the forbidden bands, and a parameter $\sigma(E)$ of interest in the treatment of perturbed periodic systems is introduced. Expansions are given for solutions of the wave equation near the band edges, in both the permitted and forbidden bands. A.

530.16

2198. Statistics of multi-component systems (phase conversions of the second kind). B. T. Geĭlikman. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 5) 631–3 (1949) *In Russian.*

530.16

2199. Some general properties of the integral of configuration of a system of particles with interaction. L. van Hove. *Physica*, **15**, 951–61 (*Dec.*, 1949) *In French.*

For an assembly of N interacting particles, enclosed in a region D of space, the Helmholtz free energy per particle and the pressure, as defined by means of Gibbs's configuration integral, are considered. A rigorous proof, based only on the consideration of the configuration integral, is given for the following well-known thermodynamic properties: when N is very large (more precisely, tends to infinity), the free energy per particle has a finite limiting value, depending on temp., intermolecular forces, specific volume v, but not on the shape of D; it is a continuous decreasing function of v, the derivative of which exists and defines the pressure; the pressure is a non-increasing function of v. This confirms the often expressed opinion that a complete evaluation of Gibbs's integral can never lead to isothermals with loops corresponding to metastable states. The assumptions made are essentially a positive incompressibility radius of the particles and intermolecular forces approaching zero rapidly enough for large separations. A.

GENERAL MECHANICS
MECHANICS OF SOLIDS 531

531.19 : 533.73

Theory of critical fluctuations. *See Abstr.* 2254

531.224

2200. A general solution for the bending of beams on an elastic foundation of arbitrary continuity. M. Hetényi. *J. Appl. Phys.*, **21**, 55–8 (*Jan.*, 1950).

531.224.8 : 621–72

2201. On highly compressible helical springs and rubber rods, and their application for vibration-free mountings. IV. J. A. Haringx. *Philips Res. Rep.*, **4**, 261–90 (*Aug.*, 1949).

[See Abstr. 3024 (1949)]. The different types of vibration-free mounting are treated in the 1-dimensional case only. From the well-known elementary systems with relative or absolute damping the latter is superior, since the relative damping unfavourably affects the forced vibrations at frequencies $> \sqrt{2}\times$ the resonant frequency. Absolute damping can unfortunately not be realized, but can be imitated by applying an auxiliary mass in addition to the damping element. Usually the application of such a damped dynamic vibration absorber is limited by the demand that the auxiliary mass shall be small in

elation to the main mass; with vibration-free mounting of instruments, however, there is in general no objection to the auxiliary mass being so large as to be able to take full advantage of the damping properties of this system in the region of the resonances. For optimum results some constructional conditions in respect of the spring rigidities and the coefficient of damping have to be satisfied. To determine these, the forced vibrations are examined by means of frequency characteristics, whilst for the judgment of the decay of the free vibrations a fictitious logarithmic decrement is introduced. A.

531.25

2202. Numerical methods in the solution of problems of nonlinear elasticity. W. KAPLAN. *Proc. Symp. Appl. Math.*, **1**, *New York, American Mathematical Society* (1949) 194–6.

A discussion is given of the methods of relaxation and gradients for determining the equilibrium position of a body from the solution of a set of simultaneous nonlinear equations. MATHEMATICAL REVIEWS

531.258

2203. Elastic deformations of infinite strips. H. G. HOPKINS. *Proc. Camb. Phil. Soc.*, **46** (*Pt I*) 164–81 (*Jan.*, 1950).

Fourier integrals are used to solve some elastic problems of generalized plane stress and small transverse displacements in infinitely long, rectangular, isotropic plates stressed only at their edges. A.

531.259.2

2204. On the calculation of the internal stress in a cylindrical transformation system. M. SATO AND Y. TINO. *J. Sci. Res. Inst., Tokyo*, **44**, 59–62 (*Nov.*, 1949) *In German.*

The authors apply the transformation methods of Honda to obtain the max. and mean stresses in a circular cylinder: the answers being $\frac{8}{9}k(\delta v/v)$ and $0{\cdot}234\ k(\delta v/v)$ respectively, where k is the volume modulus of elasticity. G. O. BAINES

531.3

2205. Response of an elastically non-linear system to transient disturbances. R. L. EVALDSON, R. S. AYRE AND L. S. JACOBSEN. *J. Franklin Inst.*, **248**, 473–94 (*Dec.*, 1949).

531.43

2206. On the magnitude of the mechanical component of solid friction. C. D. STRANG AND C. R. LEWIS. *J. Appl. Phys.*, **20**, 1164–7 (*Dec.*, 1949).

An experiment was performed in order to determine the magnitude of that portion of dry, kinetic friction which is contributed by Coulomb friction, or the mechanical interlocking of surface irregularities. The results indicate that the work of the mechanical component of friction accounts for only a few % of the work of total measured friction. A.

531.51

2207. On an approximate formula for the radius of action of gravitating masses. H. J. RODEWALD. *Z. Naturforsch.*, **4a**, 224–6 (*June*, 1949) *In German.*

The formula given is $a = R\sqrt{(m/M)}$, where R is the distance between M and m, $m \ll M$, and a the distance from m at which the gravitational attraction of both bodies is equal. Observed limits of cosmical distances are tabulated for 11 classes of masses ranging from the electron to nebular clusters and compared with calculated a-values. General agreement is noted. The same is stated to apply to the extreme distances within the planetary satellite-systems, which are also compared with hypothetical values according to Roche, Hill, Laplace, v. Weizsäcker. A possible "universal density-law" is suggested. A. BEER

531.52 : 534.01

2208. On the fall of a bar. H. PAILLOUX. *C.R. Acad. Sci., Paris*, **229**, 1118–20 (*Nov.* 28, 1949) *In French.*

In measuring the acceleration due to gravity by observing the fall of a graduated metal rule, longitudinal vibrations in the metal give rise to a possible source of error. The mode of vibration is calculated when an elastic bar, initially vertical and supported at its lower end, is suddenly released. The usual method of solving the one-dimensional wave equation is modified to allow for the discontinuous change in stress at the lower end on release. J. G. OLDROYD

MECHANICAL MEASUREMENTS 531.7

531.714

2209. An apparatus for measuring small changes in linear dimensions. D. G. R. BONNELL AND A. WATSON. *J. Sci. Instrum.*, **27**, 10–12 (*Jan.*, 1950).

During the study of the effect of freezing on certain building materials, it became necessary to develop an apparatus to measure small linear changes in 2 dimensions. In the apparatus described, movement of the specimen is magnified by the change in the angle of reflection of a beam of light incident on a system of rotating mirrors. A device is incorporated to translate horizontal movements of the specimen into vertical movements on the extensometer. A.

531.717 : 621.317.39

2210. Radioactive thickness gage for moving materials. J. R. CARLIN. *Electronics*, **22**, 110–13 (*Oct.*, 1949).

β- and γ-rays, emitted by easily obtainable radioisotopes, can be used in conjunction with an ion chamber and an amplifier for this purpose to cover a density range of $0{\cdot}001$–2 g/cm^2, corresponding to thicknesses of $0{\cdot}000015$ in. in Al to $0{\cdot}1$ in. in steel. β-rays are preferable because of their greater ionizing ability, but both provide more stability than the usual G.M. tube. Choice of isotope depends mainly upon max. weight/area to be measured, but also on the half-life value. The basic circuit following the ion chamber is an electrometer valve with a centre-zero backed-off meter. As an example of sensitivity, 1 millicurie of Sr^{90} used in conjunction with a 5-litre ion chamber and a CK571AX electrometer valve will produce a current of $\sim 10^{-9}$ A. A more elaborate equipment, embodying a self-balancing potentiometer-type recorder with automatic standardization effected at $\sim \frac{1}{2}$-hourly intervals, is also described. Health hazards are easily avoided. H. G. M. SPRATT (R)

531.752

2211. A knife-edge balance for weighings of the highest accuracy. F. A. GOULD. *Proc. Phys. Soc. B*, **62**, 817–28 (*Dec.*, 1949).

A detailed description is given of the balance used at the N.P.L. for the most accurate weighings made in the comparison of fundamental standards of mass. Among the several unique features of this balance are the design of the beam, stirrups and pans, the use of recognized methods of geometrical constraint for precise location of these parts, the accuracy of construction, particularly of the knives, and the fineness of the positional adjustments of the components. In technique of weighing, this balance also presents novel features. It is installed in a vault and, once it is loaded with the masses to be compared, the operations of controlling and reading the balance are entirely effected from outside the closed vault, mechanical means being employed for interchanging the loads undergoing comparison. Moreover, the technique of weighing is so arranged that a series of weighings of standards of mass from each arm of the balance in turn is completed without disturbing the contacts between the knives and their bearing planes. Largely as the result of using this technique, an accuracy of $\pm$ 0·001 mg, viz. 1 part in 10^9, has been attained in the comparison of kilogram masses of appropriate stability. A.

531.765 : 621.317.39

2212. Electronic ultra-chronograph. A. PEUTEMAN. *Ann. Franç. Chronom.*, **3** (*No.* 2) 157–74 (1949) *In French.*

A chronograph is described which permits the number of oscillations produced within short time intervals to be read on a dotted spiral on a c.r.o. The times to be measured refer to a fraction of a μsec. A h.f. generator supplies the oscillations for the time base and synchronizes a l.f. generator. The oscillations of both generators are applied to the plates of an oscillograph tube. The supply of the h.f. oscillations is controlled by a thyratron which itself is controlled by amplified pulses at the beginning and at the end of the time interval under consideration. The theory and circuits of the apparatus are given in detail. R. H. HERZ

MECHANICS OF FLUIDS 532

532.133

2213. An investigation of the flow processes in high polymers. W. SCHEELE. *Z. Naturforsch.*, **4a**, 433–9 (*Sept.*, 1949) *In German.*

The rate of flow is expressed as a power function of the shearing stress and from this the work of deformation is defined. Polyvinyl acetate gives linear curves plotting log (stress) *v.* log (rate of flow). The slope of these curves is approx. independent of temp., but their position is strongly temp. dependent. Log (work of deformation) is linearly related to the reciprocal of the temp. and the slope of this curve depends on the degree of polymerization. J. E. CAFFYN

532.13

2214. The viscosity of suspensions of sphere J. V. ROBINSON. *J. Phys. Coll. Chem.*, **53**, 1042–5 (*Oct.*, 1949).

The Einstein equation is extended to higher co centrations by assuming that the specific viscosity also inversely $\propto$ the volume of free liquid in th suspension. The resulting equation is tested usin suspensions of pyrex glass spheres in two motor oil castor oil, polyethylene glycol, corn syrup and sucros solution up to concentrations of approx. 70% b weight. The viscosity measurements were made in rotational viscometer described by Buchdahl [Abst 1748 (1947)], with slight modification. Linea relationships were obtained plotting vol. conc./sp viscosity against volume concentration. J. E. CAFFY

532.5 : 621.317.729 : 518.

Apparatus for the experimental solution of hydro dynamic problems with the method of electrica analogy. *See Abstr.* 2122

532.5

2215. Application of the electrical analogy in flui mechanics research. P. G. HUBBARD. *Rev. Sci Instrum.*, **20**, 802–7 (*Nov.*, 1949).

The electrolytic bath and a modification thereo are presented as valuable tools in fundamenta investigations of potential fluid flow. Principles an techniques are presented in full, together with som typical results which indicate the scope of the metho and the accuracy obtainable. Particular emphasis i placed upon techniques which permit the high accuracy necessary in most studies. A

532.516

2216. On the boundary layer at a plane or tube in a periodically oscillating stream of compressible viscous fluid. M. Z. KRZYWOBLOCKI. *Öst. Ingen. Arch.*, **3** (*No.* 5) 404–21 (1949).

The treatment of this problem by Rayleigh and by Schlichting (the latter used the results of the boundary-layer theory) produced partially conflicting solutions and therefore necessitated a more rigorous formulation of the problem. The author obtains a satisfactory description of the transversal velocity component which depends, as might be expected, on the viscosity of the fluid. A.

532.517

2217. Tangential viscous forces at high velocity gradients. M. G. VIGUIER. *Experientia*, **5** (*No.* 10) 397–8 (1949) *In French.*

The viscous stress is derived from classical kinetic theory retaining third-order terms in the velocity gradient; the result is applied to the case of flow over a flat plate in an incompressible fluid. The theoretical curve of the viscous drag against R has a minimum. J. E. CAFFYN

532.517.4

2218. On the hot-wire length correction. S. CORRSIN AND L. S. G. KOVASZNAY. Letter in *Phys. Rev.*, **75** 1954 (*June* 15, 1949).

Draws attention to 2 erroneous conclusions in a recent letter by Frenkiel [Abstr. 5989 (1949)]. These are: (*a*) the longitudinal turbulent energy measured by the hot wire does not, as stated by Frenkiel $\rightarrow 0$ as the wire length $\rightarrow \infty$; (*b*) for isotropic tur

ulence with a Gaussian longitudinal correlation nction, the correction factor I_b is not =, but always -, unity. A. SCHOFIELD

532.517.4

219. Erratum: The influence of the length of a hot ire on the measurements of turbulence. F. N. RENKIEL. *Phys. Rev.*, **76,** 686 (*Sept.* 1, 1949). See Abstr. 5989 (1949).

532.517.4

220. On the hot-wire length correction. F. N. RENKIEL. *Phys. Rev.*, **76,** 999 (*Oct.* 1, 1949). Comments on Abstr. 2218–19 (1950).

532.517.4

221. On the concept of similarity in the theory of sotropic turbulence. T. VON KÁRMÁN AND C. C. LIN. *Rev. Mod. Phys.*, **21,** 516–19 (*July*, 1949).

At low Reynolds numbers (*Re*) the decay of turbulence consists essentially of viscous dissipation of energy separately in each frequency interval, and the turbulence spectrum is similar throughout the process of decay. When *Re* is large, a second phenomenon, that of transfer of energy from one frequency interval to another, becomes appreciable; the purpose of this paper is to elucidate the effect of energy transfer upon spectral distribution. An underlying concept is that during the process of decay the spectrum shows a tendency to become similar; if this is so the spectral function F can be written in the form $U^2l\phi(kl)$ where U and l are a typical velocity and length, k is the wave number, and ϕ an arbitrary function. For practical application it is necessary to link U and l with directly measurable quantities such as the kinematic viscosity ν, Loitsiansky's invariant J_0, and the rate of energy dissipation ε. This is done by a dimensional argument assuming that: in the high-frequency range U and l are determined by ν and ε only; in the medium frequency range by ε and a parameter D characteristic of the eddy-diffusion process; and in the low-frequency range by J_0 and D. In a few special cases the results are shown to agree with those of earlier and more elaborate theoretical investigations, but lack of experimental observations over a long decay period for large *Re* precludes a comprehensive check. A. SCHOFIELD

532.517.4

2222. On Heisenberg's elementary theory of turbulence. S. CHANDRASEKHAR. *Proc. Roy. Soc. A*, **200,** 20–33 (*Dec.* 7, 1949).

The spectrum of turbulence is considered on the basis of an elementary theory recently developed by Heisenberg [Abstr. 469, 4525 (1949)]. Explicit solutions for the spectrum have been obtained both when the conditions are stationary and an equilibrium spectrum obtains and when the conditions are non-stationary and the turbulence is decaying. In the former case the problem admits of an explicit solution. In the latter case the problem reduces to determining a one-parametric family of solutions of a certain second-order differential equation. The decay spectra for various values of the Reynolds number (which remains constant during the decay) are illustrated. A.

532.517.4 : 534.222.1

The influence of turbulence on the propagation of sound. *See Abstr.* 2263

532.528

2223. On the free boundaries of an ideal fluid. I–II. M. SHIFFMAN. *Commun. Appl. Math.*, **1,** 88–99 (*Jan.*, 1948); **2,** 1–11 (*March*, 1949).

532.528 : 541.6 : 534.321.9

2224. Depolymerization by ultrasonic irradiation: the role of cavitation. A. WEISSLER. *J. Appl. Phys.*, **21,** 171–3 (*Feb.*, 1950).

Contrary to current belief, cavitation has been found responsible for the depolymerizing effect of intense ultrasonic waves. This was demonstrated by irradiating two portions of a 1% polystyrene solution in toluene under conditions identical except for the following. The first portion was given no special prior treatment, showed many cavitation bubbles during irradiation and decreased in molecular weight (as measured by the intrinsic viscosity) to about $\frac{1}{10}$ of the initial value. The second portion was given a preliminary treatment of degassing by boiling under vacuum, showed no cavitation bubbles during the irradiation and underwent no appreciable change in molecular weight. Oxidants known to be produced by ultrasonic waves in solutions containing dissolved oxygen or nitrogen cannot be responsible for the degradation, because substantially the same amount of depolymerization occurs even when helium is the only gas present. A.

532.542.4

2225. Laminar flow in a curved tube. R. COMOLET. *C.R. Acad. Sci., Paris*, **229,** 342–3 (*Aug.* 1, 1949) *In French.*

It has been shown [*C.R. Acad. Sci., Paris*, **226,** 2049 (1948)] that the critical Reynolds number at which water flowing in a tube becomes turbulent is lowered greatly by a slight curvature of the tube. A quantitative study is here made, using a flexible tube projecting from a reservoir. P. M. DAVIDSON

532.58

2226. The impact of a body on a water surface at an arbitrary angle. L. TRILLING. *J. Appl. Phys.*, **21,** 161–70 (*Feb.*, 1950).

This paper presents an approximate method of determining the pressure distribution during impact on the surface of a body which strikes a horizontal water surface at an arbitrary angle. The effect of the splash is neglected and the pressure on the free boundary is assumed proportional to the potential, as if the process were an impulse. The shape of the submerged portion of the striking body is approximated by a semi-ellipse (two dimensions), by a hemisphere, half an ellipsoid of revolution and half a general ellipsoid. Under those conditions, explicit results for the pressure distribution are found. As a special example, the impact pressures on a sphere striking at 45° angle are computed in detail. A.

532.582.3

2227. Surface waves on deep water in the presence of a submerged circular cylinder. I. F. URSELL. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 1) 141–52 (*Jan.*, 1950).

A method is given for the calculation of the surface waves of small amplitude generated on deep water by a normal velocity distribution of period $2\pi/\sigma$ prescribed over a submerged circular cylinder. The method of solution involves a system of linear equations in an infinite number of unknowns; this

system always possesses a solution. The unknowns may be obtained as power series in a parameter *Ka*, convergent for sufficiently small values of the parameter. When the parameter is not small, the equations can be solved by infinite determinants. It is shown that the reflection coefficient of waves incident on a fixed circular cylinder vanishes, as was first shown by Dean. The pulsations of a submerged cylinder are discussed when the normal velocity is the same at all points of the cylinder at any given time. A.

532.582.3

2228. Surface waves on deep water in the presence of a submerged circular cylinder. II. F. URSELL. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 1) 153–8 (*Jan.*, 1950).

In Part I a method was given for constructing a wave potential when the normal velocity is a prescribed function of the angular variable on a submerged circular cylinder. It was shown that the method breaks down for values of the parameters *Ka* and *Kf* for which a certain infinite determinant vanishes. The vanishing of this determinant implies the existence of a non-trivial velocity potential, such that the normal velocity vanishes on the cylinder and both velocity components vanish at infinity. In this part of the paper it is shown that there can be no non-trivial solution of this kind; in other words, the infinite determinant does not vanish. In the absence of a general uniqueness theory for surface waves it seems worth while to establish this particular result. A.

532.59

2229. Speed of wave energy. P. J. H. UNNA. Letter in *Nature, Lond.*, **164**, 887–8 (*Nov.* 19, 1949).

Discusses the speed at which energy may be regarded as travelling at various depths in water waves of various types. P. M. DAVIDSON

532.59 : 538.69

2230. Experimental investigations of magneto-hydrodynamic waves. S. LUNDQUIST. *Phys. Rev.*, 76, 1805–9 (*Dec.* 15, 1949).

The extreme mathematical difficulties involved in an exact treatment make it necessary to consider experimental investigations. The fundamental equations are solved for cylindrically limited waves, a case which seems to be best adapted for experiments. It is shown that an "ideal" magneto-hydrodynamic wave in a liquid with finite conductivity can exist only in a certain frequency interval. The upper limit is set by the conductivity and the magnetic field strength. Above this value the waves degenerate into skin-waves. The lowest frequency is determined by the geometrical dimensions and by the conductivity. Waves in different liquids are compared, and liquid Na is found to be the best medium for experiment. A brief account is given of a preliminary experiment and other investigations are proposed. A.

CAPILLARITY 532.6

532.612.4

2231. Surface tensions of pure liquids and liquid mixtures. H. P. MEISSNER AND A. S. MICHAELS. *Industr. Engng Chem.*, **41**, 2782–7 (*Dec.*, 1949).

A method for estimating the surface tension of mixtures of organic liquids from the refractive index is presented. Empirical relations are formulat which permit estimation of surface tensions aqueous solutions with comparable accuracy.

532.612.4 : 536.42

Effect of surface tension on heat transfer in boili *See Abstr.* 2402

532.

2232. Electric and mechanical properties of th liquid films. K. D. ZOLTOEV. *J. Tech. Phys., USS* **19**, 1146–53 (*Oct.*, 1949) *In Russian.*

3 problems are considered: (1) measurement the thickness of liquid films by electric metho (2) differences between the properties of a film an those of thicker layers of the same substanc (3) mechanism of the disruption of liquid film Methods were developed for obtaining films betwee a solid surface and an Hg surface, and between tw Hg surfaces, respectively, also for measuring fil thicknesses by conductivity. An oil film 10^{-5} c thick has the same electrical properties as thicker c layers. The thickness of an oil film formed betwee Hg surfaces decreases gradually down to a valu where the electric resistance seems to vanish.

B. F. KRAU

532.6

2233. Evidence of long range force in capillar phenomena. G. ANTONOFF. *Rec. Trav. Chim. Pay Bas*, **64**, 1011–12 (*Nov.*, 1949).

MOLECULAR THEORY OF LIQUIDS 532.

532.7 : 535.43 : 537.53

Generalization of the Born and Green theory o fluids to mixtures of molecules. *See Abstr.* 2490

532.71

2234. Effect of a variable field on the process o osmosis. Z. LÁSZLÓ. *Hungar. Acta Phys.*, **1** (*No.* 4 44–53 (1949) *In German.*

Two compartments of a glass vessel were separate by a glass filter and electrodes were placed in eac compartment which contained different liquid initially at the same heights. The field was applie between the electrodes and the levels and refractiv indices of the liquids in the two compartments wer measured. With benzene and nitrobenzene th diffusion is more rapid with the field than without i The level of the nitrobenzene, which falls if no fiel is applied, falls initially when the field is switched on and then rises, the rise increasing considerably wit increasing field strength. Similar experiments wer carried out with benzene and 1 : 2-dichloroethan and with benzene and pyridine. The effect is observe only if one or both of the liquids is polar. The effe on the osmosis is probably due to the change of degre of association of the polar liquid in the field.

A. J. ME

532.7

2235. Diffusion in media with variable propertie II. The effect of a variable diffusion coefficient on th concentration-distance relationship in the non-stead state. J. CRANK AND M. E. HENRY. *Trans. Farad Soc.*, **45**, 1119–30 (*Dec.*, 1949).

Concentration-distance curves are calculated fo

diffusion coeffs. which depend on concentration in three different ways, and which may have a range of as much as 200-fold. The results are presented graphically in a form convenient for interpolation. A method is suggested by which an approximate concentration-distance curve can be obtained, with relatively little labour, for any diffusion coeff. which depends on concentration, not necessarily in one of the ways for which the detailed results are presented. The importance of the results in connection with a recently proposed method of measuring variable diffusion coeffs. is discussed. Some insight into the nature of the sharp advancing boundary observed in many systems is provided, and the significance of the mean diffusion coeff., deduced from the rate of advance of such a boundary, is considered. A.

MECHANICS OF GASES 533

533.15

2236. Thermal diffusion in the separation tube. H. RATTE. *Z. Phys.*, **126** (*Nos* 1–2) 141–74 (1949) *In German.*

The theory of the fractionation processes in the thermal diffusion tube is derived from similar relations holding for fractional distillation. H. LONDON

533.15

2237. Diffusion phenomena in gases. I. The thermal diffusion of oxygen—experimental. E. WHALLEY, E. R. S. WINTER AND H. V. A. BRISCOE. *Trans. Faraday Soc.*, **45**, 1085–903 (*Dec.*, 1949).

The thermal diffusion factor of O gas has been determined at 3 temps. The construction and operation of a thermal diffusion column designed to enrich O^{18} in O gas is described and the results detailed. A.

533.15

2238. Diffusion phenomena in gases. II. The thermal diffusion of oxygen—theoretical. E. WHALLEY AND E. R. S. WINTER. *Trans. Faraday Soc.*, **45**, 1091–7 (*Dec.*, 1949).

Experimental values for O gas agree well with those calculated using the 13/7 intermolecular force model. The performance of the thermal diffusion column described in Part I [preceding Abstr.] is in reasonable agreement with theory. It is shown that the performance of Lauder's thermal diffusion column is not in agreement with theory and it is concluded that the probable reasons for this are the presence of turbulence in the gas flow, and the inadequacy of the molecular model used by Furry and Jones in deriving the general theory of the thermal diffusion column. A.

533.15 : 539.155.2

2239. The separation tube. VII. Enrichment of the heavy xenon isotopes. A remark regarding the separation of multicomponent mixtures. K. CLUSIUS. *Helv. Phys. Acta*, **22** (*No.* 4) 473–8 (1949) *In German.*

In a 27m thermal diffusion plant the heavy isotopes of Xe are enriched, giving an atomic weight of 134·32 as compared with the normal 131·31. It is suggested to improve the performance in the separation of complex isotope mixtures like Xe, by admixing gases of suitable masses and molecular cross-sections which would accumulate between the isotopic components. H. LONDON

533.21

2240. A comparison of the compressibilities of some gases with that of nitrogen at pressures below one atmosphere. G. A. BOTTOMLEY, D. S. MASSIE AND R. WHYTLAW-GRAY. *Proc. Roy. Soc. A*, **200**, 201–18 (*Jan.* 6, 1950).

A differential method for comparing the compressibilities of gases at pressures below 1 atm. has been developed in which many of the errors inherent in methods employed previously have been to a large extent eliminated, especially those due to meniscus volume changes and capillary depression. Using pure N as a standard the low-pressure isothermals of CO, CO_2, N_2O, O, ethylene and propane have been determined at a temp. of 22·05°C. The deviations of the individual points from straight lines do not in most cases exceed 2 parts in 100 000. In no case, even with propane, was any curvature in the isotherms detectable. The contention of Moles and other recent workers that the molecular weights of liquefiable gases can be determined to a high degree of accuracy by linear extrapolation is rendered highly probable by this fresh evidence. A.

533.24 : 536.48

2241. A small helium liquefier and portable cryostat. L. C. JACKSON AND H. PRESTON-THOMAS. *J. Sci. Instrum.*, **27**, 17–19 (*Jan.*, 1950).

A small He liquefier and portable cryostat are described. This apparatus enables a laboratory producing liquid He in amounts of the order of 50 cm^3 or less to transport the liquid to any place where it may be required. Hitherto small liquefiers have had cryostats inseparable from the main liquefying systems. An account is given of the use of a portable cryostat for the demonstration of low-temp. and liquid-He pheonmena to a large audience. A.

533.5 : 531.788.12

2242. McLeod-type alloy-filled vacuum gauge. J. GROSZKOWSKI. Letter in *Nature, Lond.*, **164**, 886–7 (*Nov.* 19, 1949).

The use of an alloy (50% Bi, 10% Cd, 27% Pb, 13% Sn), m.p. 70°C, sp. gravity 9·6, in place of the usual Hg is discussed, and some of the consequent constructional changes of the gauge mentioned. The first experimental gauge was made with 0·2 cm diameter glass capillary and 160 cm^3 compression bulb, and operated with the alloy at 100°C. The pressure p mm Hg and column height h mm were related by $p = 2 \times 10^{-5} h^2$. S. WEINTROUB

533.5 : 531.788.732

2243. Construction and applications of a new design of the Philips vacuum gauge. F. M. PENNING AND K. NIENHUIS. *Philips Tech. Rev.*, **11**, 116–22 (*Oct.*, 1949).

The pressure range of the new gauge based on the original principle but employing a different electrode system extends from 10^{-4} to 10^{-6} mm Hg and probably below 10^{-7} mm Hg. The old and new designs are described and leak detection using the new gauge and substitute gases, with and without the use of a heated

wall of Pd, is discussed at some length. There are 11 illustrations and graphs. G. WITTENBERG

533.5 : 536.422

2244. Evaporation and outgassing in an inert atmosphere. R. L. LONGINI. *J. Appl. Phys.*, **21**, 81–3 (*Feb.*, 1950).

Experiments in vacuum and in an inert atmosphere show that the latter is advantageous for outgassing Sb if loss by evaporation is intolerable. A simple theory based on well-established kinetic theory considerations is given which may explain and did predict the results. A.

533.56

2245. A new type of diffusion pump. E. L. HARRINGTON. *Rev. Sci. Instrum.*, **20**, 761–2 (*Nov.*, 1949).

Certain features have been added to the standard diffusion pump which give to it certain definite advantages in both operation and control without introducing any new limitations. A.

533.56

2246. Pumping speed of diffusion pumps below limiting pressure. C. E. BERRY. Note in *Rev. Sci. Instrum.*, **20**, 835–6 (*Nov.*, 1949).

Experimental work with *VMF*-20 air-cooled oil diffusion pump supports Sears's [Abstr. 90 (1950)] hypothesis that the true pumping speed of a diffusion pump should be a constant below a critical pressure. The partial pressure of a test gas not normally evolved from the system should be measured with a mass spectrometer. The experimental set-up is illustrated and described. Confirming results are given.

G. WITTENBERG

533.6.011.3

2247. Application of Galerkin's method to compressible fluid flow problems. C.-T. WANG AND R. F. BRODSKY. Letter in *J. Appl. Phys.*, **20**, 1255–6 (*Dec.*, 1949).

533.6.011.5

2248. The shock tube: a facility for investigations in fluid dynamics. W. BLEAKNEY, D. K. WEIMER AND C. H. FLETCHER. *Rev. Sci. Instrum.*, **20**, 807–15 (*Nov.*, 1949).

A qualitative description of the theory of the operation of a shock tube is given together with a discussion of its design. The construction of a particular tube 4 in × 18 in × 38 ft is described as well as certain auxiliary equipment needed in its operation. The technique of operating the device and comparisons of its performance with expectations are discussed. This tube has been used to study certain properties of shock waves and to obtain a flow field of marked uniformity and freedom from turbulence. The Mach number of this flow may be adjusted at will from zero to the supersonic range without difficulty. An interferometer makes it possible to obtain an instantaneous picture of the density field so that the apparatus may be used as a very efficient transonic wind tunnel.

A.

533.6.011.5

2249. The shock strength in supersonic "conical fields." M. J. LIGHTHILL. *Phil. Mag.*, **40**, 1202–23 (*Dec.*, 1949).

Using the exact equations of motion, and a method previously described, the true behaviour of flow ne the Mach cone is deduced. Near to it is a shoc and the strength of the shock can be derived approx mately from the linearized solution alone. Exampl are given from a number of problems, whose linearize solution is known. In the supersonic flow past ar conical surface all of whose generators make a sma angle with the main stream, the shock is of uniform strength (to a first approx.), which depends only o the solid angle of the cone. Two examples fro supersonic wing theory are given. The reasons wh linear theory gives a correct first approximation to th flow field within the Mach cone are given.

L. S. GODDAR

533.6.08 : 551.508.

2250. Approximate calculation of the characteristic of hot-wire anemometers. G. DÄTWYLER. *C.R. Aca Sci., Paris*, **229**, 977–8 (*Nov.* 14, 1949) *In French.*

The hot wire, of length L, is considered to be pa of an infinitely long wire. The numerical values o c_0 and n for different ranges of Re in Ulsamer' relation [*Forschung*, **3**, 94–8 (1932)] $Nu = c_0(Re)^n$ ar quoted. Derived from this relation and from th equation for thermal balance between the heated wir and the surrounding air expressions for the current in the wire, unit tension E/L, temp. constan $\propto (dR/dI)/E$, and sensitivity (dE/dU), valid fo I = constant, are stated. R is the wire resistance and U the velocity of flow of the air. S. WEINTROU

533.691

2251. The reversal theorem of linearized supersonic airfoil theory. M. M. MUNK. *J. Appl. Phys.*, **21** 159–61 (*Feb.*, 1950).

It is demonstrated on simple dynamic principles that a supersonic airfoil under certain conditions exhibits the same drag and the same lift slope regardless of whether it flies forward or backward. A.

MOLECULAR THEORY OF GASES 533.7

533.7

2252. On the Bose–Einstein condensation of a perfect gas. S. R. DE GROOT AND C. A. TEN SELDAM. Letter in *Physica*, **15**, 671–2 (*Aug.*, 1949).

Results are given for the general case of a w-dimensional potential field of such a shape as to give sequences of eigenvalues of the form $\varepsilon_{s_1} \ldots, \quad \varepsilon_{s_w} = \text{const} \times (h^2/m)[(s_1^\alpha - 1)/A_1^2 + \ldots (s_w^\alpha - 1)/A_w^2]$ where $1 < \alpha < 2$; $s_1, \ldots s_w$ are the w necessary quantum numbers, and $A_1, \ldots A_w$ are certain characteristic lengths of the field. For $\alpha = 2$ the field is that of a w-dimensional rectangular box and for $\alpha = 1$ that of a harmonic oscillator. The value and character of the transition point are given. For $q \equiv w/\alpha \leqslant 1$ there is no transition point, for $1 < q < 3/2$ the transition is of $>$3rd order, for $q = 3/2$ of 3rd order with finite discontinuity of d^2E/dT^2, for $3/2 < q \leqslant 2$ d^2E/dT^2 has an infinite discontinuity, for $q > 2$ dE/dT has a finite discontinuity. A discrete energy spectrum has been used in the calculations. H. LONDON

533.722

2253. On the approach to statistical equilibrium. A. F. J. SIEGERT. *Phys. Rev.*, **76**, 1708–14 (*Dec.* 1, 1949).

The distribution of a gas in momentum space as function of the time is considered as a random process. The probability of changes of the distribution in infinitesimal time intervals is assumed to be given by the "Stosszahlansatz." For the Rayleigh model of a gas the probability of a distribution as a function of the time is derived. For the Boltzmann gas with microscopic reversibility it is shown that the probability of a distribution approaches the stationary value in the limit of infinite time. A.

533.73 : 531.19

2254. Theory of critical fluctuations. M. J. KLEIN AND L. TISZA. *Phys. Rev.*, **76**, 1861–8 (*Dec.* 15, 1949).

A macroscopic system is subdivided into cells of identical size and shape arranged in a regular spatial array. The method of canonical ensembles would consider one of the cells, schematizing the rest into a "reservoir." The present "cellular method" treats the cells on an equal footing and is appropriate to deal with the fluctuations near the critical point for which the standard theory yields infinite results. Earlier theories dealing with the same problem appear as special cases of the present treatment. In particular, the critical points are defined generally enough to include the so-called λ-points in solids. The macroscopic system is invariant under the group of translations which displaces one cell into another. The macroscopic quantities (e.g. the thermodynamic parameters) are invariants of this group. A.

533.75

2255. An acceptable equation of state. Discussion. Y. ROCARD. *C.R. Acad. Sci., Paris*, **229**, 987–9 (*Nov.* 15); 1061–2 (*Nov.* 21, 1949) *In French.*

The first paper proposes a new equation of state in the form $p = (RT \exp b_1/v)/v(1 - b^2/8v^2) - a_1/v^2$ with $b_1/b = a_1/a = \exp\{cT_c[1 - (v_m/v)^{1/3}]^2/T\}$. Theoretical justification of the equation is outlined. The second paper compares deductions with experimental results. Thus for $c = 1{\cdot}34$ and $v_m/v = b/\sqrt{(8)}v$, $RT_c/p_cv_c = 3{\cdot}84$, $(v_c/R)(\partial p/\partial T) = 2{\cdot}05$, $T_1/T_c = 2{\cdot}59$, $T_1/T_2 = 0{\cdot}56$, where T_1 is the Boyle temp. and T_2 the Joule-Thomson inversion temp. Saturation vapour pressures are well represented (benzene and ethyl acetate). The value of c may be calculated for a given intermolecular attractive force. For an inverse seventh power law, as proposed by F. London, the value is $c = a/2bRT_c$, which gives on evaluation exactly $1{\cdot}34$ as used in the comparisons. Calculated values of surface tension using this equation are in reasonable agreement with experimental values. F. E. HOARE

VIBRATIONS . ACOUSTICS 534

534.154 : 621.395.62.089.6

2256. A substitution method for the absolute calibration of vibration pick-ups. N. A. HASKELL. *Geophysics*, **14**, 558–61 (*Oct.*, 1949).

By making use of the general relations between input and output currents and voltages in 4-terminal networks of bilateral impedances a relationship is derived between the velocity response of a reversible vibration pick-up and the velocity output of the same device, when used as a source of mechanical vibrations. It is shown that any vibration pick-up may be calibrated in absolute terms as a function of frequency by purely electrical measurements (input current and output voltage) made on the given pick-up, an auxiliary reversible pick-up, and a variable frequency driver. A.

534.21

2257. General expression of Huyghens principle for the damped propagation of longitudinal waves. J. BRODIN. *C.R. Acad. Sci., Paris*, **229**, 989–91 (*Nov.* 14, 1949) *In French.*

A wave, emitted by sources inside a domain limited by a surface S is, outside S, identical with a wave emitted by sources distributed over the surface S. Assuming a medium which is not perfectly transparent, the author derives all the solutions of Huyghens' principle as stated above. A. B. WOOD

534.212

2258. The propagation of sound waves in an open-ended channel. W. CHESTER. *Phil. Mag.*, **41**, 11–33 (*Jan.*, 1950).

An exact solution is obtained for the problem of a harmonic wave of sound approaching the open end of a 2-dimensional channel, and suffering reflection and transmission. Within a certain wavelength range, the wave returning along the channel becomes sensibly plane at large distances from the mouth, the reflection coeff. being $\exp[-2\pi b/\lambda]$, where $2b$ is the width of the channel and λ is the wavelength. Explicit formulae are also obtained for the change of phase in the returning wave, and for the transmitted energy. It is also shown that the solution can be used to deduce the energy absorbed from a plane wave external to the channel and approaching from an arbitrary direction. A.

534.213

2259. The part played by the joints between crystals in the anomalies of the propagation of ultrasonic waves in metals. P. BASTIEN, J. BLETON AND E. DE KERVERSAU. *C.R. Acad. Sci., Paris*, **229**, 1016–18 (*Nov.* 18, 1949) *In French.*

When an ultrasonic transducer is moved very slightly along the surface of some crystalline metals, parasitic reflections occur. A theoretical treatment has been made of this phenomenon, firstly on the assumption that there is a variation of the acoustical impedance in the path of the waves due to the elastic anisotropy of the crystals and to their differing orientations in the material. The conditions giving resonance were studied and resonance was found to occur when the grains had a dimension of $\lambda/4$, which is not in agreement with the experimental data. A second attack was made assuming the joints between the grains to be quite different elastically from the crystals, and resonance was found possible only when the crystals had a dimension of $\lambda/2$, and this fitted the experimental data. A. C. WHIFFIN

534.213

2260. Transmission of elastic waves through a stratified solid medium. W. T. THOMSON. *J. Appl. Phys.*, **21**, 89–93 (*Feb.*, 1950).

The transmission of a plane elastic wave at oblique incidence through a stratified solid medium consisting of any number of parallel plates of different material and thickness is studied theoretically. The matrix method is used to systematize the analysis and to present the equations in a form suitable for computation. A.

534.213.4

2261. Vibrations of a gas column. H. A. KRAMERS. *Physica*, **15**, 971–84 (*Dec.*, 1949).

In low-temp. experiments, spontaneous vibrations may occur in gas columns if the temp. of the tube containing the column varies markedly along its length. This paper investigates in detail the sign of the damping of the small oscillations which the gas may perform. Although owing to the temp. variation there may be a marked tendency towards a negative damping of the vibrations, it appears that this effect does not always suffice to account for the observed instability. Its explanation has perhaps to be sought in the non-linear effects occurring in vibrations with finite amplitudes. A.

534.22 : 530.12

The velocity of sound in general relativity. *See Abstr.* 2182

534.222

2262. Researches on the waves from an explosive source. E. DUBOIS. *Mém. Artill. Franç.*, **21**, 369–93 (1947) *In French.*

By means of a piezo-electric quartz crystal, the forces due to the instantaneous pressure on an obstacle from the waves derived from an explosure source were investigated. The pressure curve consisted of an excess pressure, followed by a depression and again by a weaker excess pressure. The mechanical action which should result on the obstacle has been determined. In addition it is shown that, in the case of flat sources, there is a concentration of the emitted energy around the normal to the plane of the source.

INDEX AERONAUTICUS

534.222.1 : 532.517.4

2263. On the influence of large scale turbulence on the propagation of sound in a turbulent medium. M. G. ODINTSOV AND I. G. SHAPOSHNIKOV. *J. Tech. Phys., USSR*, **19**, 1001–9 (*Sept.*, 1949) *In Russian.*

Theoretical. The effect of turbulence on sound-propagation depends on its scale: for small-scale turbulence (small compared with the wavelength of the sound) the effect is one of scattering and dispersion, but large-scale eddies cause distortion of the acoustic wave-front which lead to periodic fluctuations in the intensity of signal at a distant receiver (acoustic fading). An investigation is made of phenomena of the second type; the influence of source-receiver distance, of wavelength, and of the mean velocity of the turbulent medium are examined. It is assumed that source-receiver distance is $\geqslant$ dimensions of the source, that compressibility of the medium is negligible, and that the mean velocity of the medium is $\ll$ that of sound. The eqns. of propagation give series solns. for θ, the phase-angle of the sound-wave, and for $L = \overline{\pi}^2/\rho c$ where $\overline{\pi}$ is the mean pressure energizing the receiver during a short period, ρ the density of the medium, and c the velocity of sound. The first 2 terms in these series are evaluated and hence the mean-square-fluctuation in sound intensity is obtained. If ΔL represents the deviation of L from its mean value over a long period, $(\Delta L)^2_{av.}$ is $\propto r^3$, where r is the source-receiver distance. An expression for the dependence of $(\Delta L)^2_{av.}$ upon the correlation function between turbulent velocity fluctuations and distance is also given, but the further step of deriving the dependence of $(\Delta L)^2_{av.}$ upon wavelength and the bulk velocity of the medium is not carried out. This further step is omitted because of uncertainty as to the way in which the correlation function is related to these two factors.

A. SCHOFIELD

534.222.2

2264. Theory of the propagation of shock waves from cylindrical charges of explosive. S. R. BRINKLEY, JR. AND J. G. KIRKWOOD. *Proc. Symp. Appl. Math.*, **1**, *New York, American Mathematical Society* (1949) 48–54.

The authors consider explosion waves from cylindrical charges when (*a*) the explosion proceeds radially from the centre-line of the charge and (*b*) the explosion wave travels axially down the charge.

MATHEMATICAL REVIEWS

534.222.2

2265. On shock-wave phenomena: Interaction of shock waves in gases. H. POLACHEK AND R. J. SEEGER. *Proc. Symp. Appl. Math.*, **1**, *New York, American Mathematical Society* (1949) 119–44.

A detailed summary of the existing mathematical theory. MATHEMATICAL REVIEWS

534.222.2

2266. Interaction of shock waves. W. BLEAKNEY AND A. H. TAUB. *Rev. Mod. Phys.*, **21**, 584–605 (*Oct.*, 1949).

The phenomenon considered is the reflection of a plane shock wave from a rigid plane wall. The shock wave may be generated by bursting a plane diaphragm separating a high-pressure chamber from a shock-tube of rectangular section. Propagation of the shock is examined through windows on opposite sides of the tube by shadow-photography, the Schlieren technique, or interferometry. The light source used is a spark of short duration; successive sparks may be used to investigate time-variation of the flow. The phenomena of reflection depend on the angle of incidence α ($\alpha = 0$ means normal incidence) and the pressure rise P_2/P_1 across the shock wave. For given P_2/P_1, the incident (I) and reflected (R) waves intersect at the wall when $\alpha \ll$ a limiting value α_s; when $\alpha \gg$ another limiting value α_0, I and R intersect at a triple point O some distance from the wall. Between O and the wall a Mach bridge wave (M) is formed. The theory of regular reflection (when I and R intersect at the wall) is presented: it is shown that for given P_2/P_1 regular reflection can occur only for $\alpha < \alpha_e$. This theoretical value α_e agrees, to within limits of exptl. error, with the observed value α_s, but there exists a small

nge of values $\alpha_e < \alpha < \alpha_0$ for which the reflection henomena are obscure. Mach reflection can at resent be treated theoretically only by making dditional assumptions regarding conditions around ne point O. If it is assumed that conditions are niform in each of the 3 zones (IOR), (IOM) and ROM) serious discrepancies exist between theory nd experiment. These can be overcome by assuming Prandtl–Meyer (angular) density-variation in the one (IOM), but it is difficult to see how such a ariation could occur ahead of the Mach bridge ave. In an appendix, recent interferometric studies Abstr. 97 (1950)] are reviewed. These show that n the zones (IOM), (IOR) conditions are very uni- orm, but that in the zone (ROM) there is a density ariation somewhat like the Prandtl–Meyer type.

A SCHOFIELD

534.222.2

2267. Solutions of the equations for the non-uniform propagation of a very strong shock-wave. I. W. P. ROBBERTSE AND J. M. BURGERS. *Proc. K. Ned. Akad. Wet.*, **52** (*No.* 9) 958–65 (1949).

If the position x at time t of a gas-element specified by the parameter s is given by $x = \phi(s, t)$, the gas-velocity immediately behind the shock-wave can be expressed in terms of $\partial\phi/\partial t$ or, independently, in terms of ds/dt along the shock-path in the x–t plane. The equality of these two expressions furnishes a condition defining ϕ; a formal solution for is possible when $\partial\phi/\partial s = f_1(s)/f_2(t)$, where f_1 and f_2 are certain special functions of s and t: in effect, specifying f_1 and f_2 defines the initial gas-density distribution. An example given concerns propagation of a shock-wave at a velocity $\gg$ that of sound, in a perfect monatomic gas; a const. gravitational force g is assumed to act in a direction opposite to that of propagation. A solution for ϕ is possible for a particular variation of initial density ρ_0. When $g = 0$, ρ_0 is approx. $\propto x^{-1\cdot75}$; this corresponds to a shock-wave whose velocity increases with time as $t^{1/3}$.

A. SCHOFIELD

534.222.2

2268. Solutions of the equations for the non-uniform propagation of a very strong shock wave. II. W. P. ROBBERTSE AND J. M. BURGERS. *Proc. K. Ned. Akad. Wet.*, **52** (*No.* 10) 1067–74 (1949).

Special solutions of the propagation equations, obtained in a previous paper [Abstr. 2267 (1950)] are compared with those obtained earlier by the first author [*Thesis, Delft* (1948)] for the case of no gravitational force ($g = 0$) and const. initial gas density ($\rho_0 = \text{const.}$). The present solutions require a variable gas-density, but it is possible to arrange that $\partial\rho_0/\partial s = 0$ and $\partial^2\rho_0/\partial s^2 = 0$ at $s = 0$ (s being a parameter specifying a certain gas element), and it is found that in this case good agreement exists between the earlier treatment and the present one. A numerical example is given by way of illustration of the theory, which, it is suggested, may have astrophysical applications.

A. SCHOFIELD

534.231

2269. Pressure distribution in the acoustical field excited by a vibrating plate. J. PACHNER. *J. Acoust. Soc. Amer.*, **21**, 617–24 (*Nov.*, 1949).

Pressure distribution in the acoustical field excited by a vibrating circular plate clamped at the edge in an infinite wall is calculated for the points the distance of which from the centre of the plate is $\geq$ 10–20 times its radius. For completeness a short survey of the theory of forced vibrations of plates is also given.

A.

534.231 : 551.596

2270. Some new experiments on the propagation of sound in the atmosphere. V. A. KRASILNIKOV AND K. M. IVANOV-SHITS. *Dokl. Akad. Nauk, SSSR*, **67** (*No* 4) 639–42 (1949) *In Russian.*

Sound waves of frequency 3–5 kc/s emitted by a 50 W generator mounted on a mast 8 m high were received by crystal microphones on similar masts 22, 45 and 67 m from the generator. Fluctuations in phase and amplitude of the microphone signal were recorded. The mean-square phase fluctuation increases as $L^{\frac{1}{2}}$ (L = distance from generator to the receiver) while the mean-square fluctuation of log. (amplitude) varies more rapidly than $L^{\frac{1}{2}}$, but less rapidly than L. The influence of L upon phase fluctuations is in agreement with theory [Krasilnikov, *Dokl. Akad. Nauk, SSSR*, **58**, 1353 (1947)], but the log (amplitude) fluctuation is discrepant; theory predicts that it should vary as $L^{\frac{3}{2}}$. The discrepancy may be attributed to variation in curvature of the wave-front, which probably occurred in these experiments, but was neglected in the theory.

A. SCHOFIELD

534.231.3

2271. Theory of passive linear electroacoustic transducers with fixed velocity distribution. L. L. FOLDY. *J. Acoust. Soc. Amer.*, **21**, 595–604 (*Nov.*, 1949).

A general theory is developed and applied to the calculation of important practical parameters of the transducer. A proof of the electroacoustic reciprocity theorem for such transducers is included. Another important theorem, the available acoustic power theorem, which states that the maximum power which can be absorbed by such a transducer from a plane wave sound field is given by the product of the intensity of the wave and the quantity $\lambda^2\delta_R/4\pi$ where λ is the wavelength of the wave and δ_R is the receiving directivity factor of the transducer relative to the direction of incidence of the wave is also proved. The paper concludes with a discussion of the available power efficiency of a transducer and its relation to the threshold pressure of the transducer.

A.

534.231.3

2272. The plane wave reciprocity parameter and its application to the calibration of electroacoustic transducers at close distances. B. D. SIMMONS AND R. J. URICK. *J. Acoust. Soc. Amer.*, **21**, 633–5 (*Nov.*, 1949).

The reciprocity parameter for a plane wave sound field is shown to be equal to $2A/\rho c$, where A is the area of the plane piston source and ρc the characteristic acoustic resistance of the medium. It is shown experimentally that the sound field in front of a plane piston source is effectively plane over a distance $\simeq A/\lambda$, and that in such a region the plane wave parameter may be used to obtain a free field calibration of the transducer by the reciprocity method.

A.

534.232

2273. The production of ultrasonic waves by gas jets. R. KLING AND J. CRABOL. *C.R. Acad. Sci., Paris*, **229**, 1209–11 (*Dec.* 5, 1949) *In French.*

Hartmann's modification of the Galton whistle may be further modified to produce ultrasonic vibrations in air. In Hartmann's siren, an air jet is directed at a hole in a rigid diaphragm which forms a resonant cavity and then impinges on a flexible membrane. By this means, an air pressure of 1·2 kg/cm² gives a frequency of 34 kc/s with a jet orifice of 1·5 mm diameter. When the resonant cavity is replaced by an arrangement in which the air jet impinges directly on the centre of a rigid plane disc, a jet orifice of 0·8 mm dia. placed 2 mm from the disc gives a frequency of 220 kc/s when an air pressure of 4·1 kg/cm² is used. A Hartmann siren operated at this pressure, and fitted with an orifice and resonator of 0·7 mm diameter, will not give frequencies > 126 kc/s. A. C. WHIFFIN

534.232 : 538.566

A new method of solving the problem of a point source of radiation in a stratified-inhomogeneous medium. *See Abstr.* 2594

534.24 : 538.566.2

2274. Reflection of plane waves from inhomogeneous layered media. L. M. BREKHOVSKIKH. *J. Tech. Phys., USSR*, **19**, 1126–35 (*Oct.*, 1949) *In Russian.*

Theoretical. An investigation of the propagation of plane e.m. or acoustic waves in media whose properties depend only on a single Cartesian co-ordinate z. The treatment is characterized by 2 special features: (*a*) it is applicable to an arbitrary variation of the properties of the medium along the co-ordinate z, provided that the variation is not so rapid as to cause appreciable localized distortion of the plane incident wave; (*b*) the wave-propagation equations are, at an early stage, transformed into an equation in terms of the local reflection coeff. $V(z)$. The transformed eqn. is solved by Picard's method to give a series expansion for $V(z)$. Two diff. series expansions are given; one in which the successive approx. is started from an initial equation of zero order in V (solution A), and another in which the initial eqn. is of 1st order in V (solution B). Soln. B is, of course, much more rapidly convergent than soln. A. This is illustrated by an example, dealing with reflection of a plane e.m. wave normally incident upon a medium in which the refractive index n changes from n_0 at $z = 0$, to n_1 at $z = l$ according to the law $n = n_0[1 + (\beta - 1)\zeta]^{-1}$, where $\beta = n_0/n_1$, $\zeta = z/l$. The exact soln. of this problem was given by Rayleigh; the 2nd stage approximation from soln. A gives accurate results only up to $k_0 l = 0{\cdot}8$ (k_0 = wave no. *in vacuo*), but soln. B (to the same order of approxn.) gives values of the reflection coeff. agreeing with Rayleigh's to better than 1% for all values of $k_0 l$. A. SCHOFIELD

534.26

2275. Scattering of an underwater ultrasonic beam from liquid cylindrical obstacles. P. TAMARKIN. *J. Acoust. Soc. Amer.*, **21**, 612–16 (*Nov.*, 1949).

An ultrasonic beam (frequency, 1·145 Mc/s; wavelength, 0·13 cm) produced in water by a quartz crystal is scattered by various liquid cylindrical obstacles (diameter, 1·3 cm). These obstacles are composed of methyl and amyl alcohols, ethyl alcohol–H_2O solutions, NaCl–H_2O solutions, and diethylaniline. They provide a range of values of acoustic impedance, acoustic velocity, and ratio of obstacle diameter to wavelength. Pressure amplitude distributions are measured over various cross-sections of the scattered beam for a fixed position of the obstacles relative to the source. The scattered wave fronts are also obtained. These two types of measurements lead to the conclusion that the scattering is diffractive rather than ray acoustical. Other evidence is given which exhibits the presence of a scattered wave. A.

534.2

2276. Coupling and transitron phenomena in musical instruments. E. G. RICHARDSON. *Cent. Ass. Ing. Liège Congr.*, 6 *pp.* (1947) *In French.*

Reference is made to the electrical analogies of mechanical systems represented in various musical instruments, e.g. the piano and the flute. The vibration of coupled systems is exemplified in wind instruments—studies having been made particularly of reed organ pipes and the flute. Oscillograms are reproduced illustrating the various modes of vibration of such coupled systems, and the relative phases of the vibrating reed and the air column. A. B. WOOD

534.321

2277. Influence of humidity on the tuning of a piano. R. W. YOUNG. *J. Acoust. Soc. Amer.*, **21**, 580–5 (*Nov.*, 1949).

534.321.3

2278. Musical scales and their classification. J. M. BARBOUR. *J. Acoust. Soc. Amer.*, **21**, 586–9 (*Nov.*, 1949).

534.321.9 : 541.18.047

2279. Industrial sonic agglomeration and collection systems. H. W. DANSER AND E. P. NEUMANN. *Industr. Engng Chem.*, **41**, 2439–42 (*Nov.*, 1949).

Physical variables involved in the design of industrial sonic agglomeration and collection systems for the recovery of fine particles in gases are discussed. Included are intensity and frequency of the sound field and exposure time of the aerosol therein. Examples are presented of installations used industrially. A.

534.321.9 : 620.179.16

2280. The theory of ultrasonic materials testing. H. E. VAN VALKENBURG. *Mech. Engng, N.Y.*, **71**, 817–20 (*Oct.*, 1949).

534.321.9 : 620.179.6

2281. An ultrasonic microscope. S. YA. SOKOLOV. *J. Tech. Phys., USSR*, **19** (*No.* 2) 271–3 (1949). Also *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 3) 333–5 (1949) *In Russian.*

Description of an instrument using a pencil of supersonic rays to scan the object, the reflected waves being collected by an acoustic lens and passed to a c.r.t. Any optically opaque medium can thus be viewed. Magnification depends on the ratio of the screen dimensions of the transmitting and receiving tubes. INDEX AERONAUTICUS (R

534.372

2282. The nature of the mechanical self-oscillations produced in dry friction. N. L. KAĬDANOVSKIĬ. *J. Tech. Phys., USSR*, **19**, 985–96 (*Sept.*, 1949) *In Russian.*

Experiments disproving the contentions of Bowden's and Leben's theory (*Proc. Roy. Soc. A*, **169**, 371, 1939) where the role of the damping in the mechanism of excitation of the oscillation pulses in dry friction is concerned. B. F. KRAUS

534.413 : 536.46

The effect of sound on laminar propane-air flames. *See Abstr.* 2415

534.421

2283. The analysis and synthesis of musical sounds. A. W. LADNER. *Electronic Engng*, **21**, 379–85 (*Oct.*, 1949).

The harmonic theory of complex musical sounds and the difference between objective (intensity, frequency and harmonic composition) and subjective sound qualities (loudness, pitch and timbre) are explained briefly. Characteristics of the human ear, relation between harmonic series and musical scale and consonance and dissonance are then discussed, and methods of analysis (harmonic analyser) and synthesis (acoustical harmonic synthesizer) indicated. Several samples of analysis and synthesis of organ sound are shown graphically, both as composite waveforms and also as Fourier spectra. The construction of the synthesizer is described, with emphasis on the very accurate manufacture of the sine wave tone wheels. The instrument is capable of combining up to the 20th harmonic of fundamentals below 230 c/s, contains special "attack" and "decay" circuits and a c.r.t. monitor. General results indicate that the synthetic reproduction of musical transients is much easier than that of complex sustained tones. A. LANDMAN

534.43

2284. Universal phonograph styli. J. D. REID. *J. Acoust. Soc. Amer.*, **21**, 590–2 (*Nov.*, 1949).

The advent of "slow-speed" records with fine grooves has resulted in the introduction of 3-speed phonographs which are unduly complex in operation. A great simplification in their mechanical complexity and in turn in the operating procedure can be obtained if the problem of changing the needle for the various types of records is eliminated. With a universal stylus, the phonograph may be designed with one-tone arm, one cartridge and the only additional operation required of the user is the selection of the correct speed. Several solutions to the problem of a universal stylus are presented. A.

534.511.2

2285. Production and observation of high frequencies by combination of several low frequencies. S. DOLINSKI. *C.R. Acad. Sci., Paris*, **229**, 812–14 (*Oct.* 24, 1949) *In French.*

After discussing the subjective and objective aspects of the formation of sum and difference tones due to the vibration of two reeds of a harmonium, the author extends the principle to the summation of any number "n" of vibrators—the summation including all possible combinations of + and − signs. Consideration is given to the application of the principle to the production of high frequency sounds by combining several low frequencies, (*a*) by a system of multiple sirens, and (*b*) by a system of vibrating bars or tuning forks. Analogous observations are also made with electromagnetic waves. A. B. WOOD

534.78

2286. Theory of speech masking by reverberation. R. H. BOLT AND A. D. MACDONALD. *J. Acoust. Soc. Amer.*, **21**, 577–80 (*Nov.*, 1949).

A general statistical theory is developed for the masking effect of reverberation on the intelligibility of words. Speech is considered a series of discrete pulses distributed statistically over a 30-db range in sound pressure level in a given frequency band. The articulation index is calculated as a function of reverberation time, using preliminary values of speech pulse lengths and spacings obtained from visible speech spectrograms. The percentage articulation for words is then calculated from the articulation index and is compared with Knudsen's experimental values. The theoretical values agree precisely with the measured values at reverberation times < 2 sec and differ by $< 17\%$ out to 6 sec. The calculations are extended to include a combination of background noise and reverberation. A.

534.83

2287. Quieting ram jet motor test stations. W. B. SNOW AND C. J. T. YOUNG. *J. Acoust. Soc. Amer.*, **21**, 626–32 (*Nov.*, 1949).

Description of duct system which enabled test cells with sound levels of up to 150 db to be operated in a residential community.

534.84

2288. The density of "reverberant action" as a criterion of acoustic equilibrium. D. FAGGIANI. *Alta Frequenza*, **18**, 160–7 (*July–Aug.*, 1949) *In Italian.*

The acoustic properties of a concert hall are determined by 3 quantities; the reverberation time T, the transmitted power W and the volume V. The optimum response, when the receiver is the human ear, is obtained by keeping the quantity T^2W/V constant. When a microphone is used instead of the ear, it is suggested that this expression should be replaced by TW/V, although this criterion is not so accurate as that given above. Experimental results are quoted which appear to confirm these conclusions. V. G. WELSBY

534.843

2289. Acoustics of rooms. M. A. S. ROSS. *Nature, Lond.*, **164**, 1080–1 (*Dec.* 24, 1949).

A review of 6 lectures by Bolt to the Acoustics Group of the Phys. Soc., Lond. Reference is made to the classical theory which assumes uniform distribution of sound energy in the room, and to its limitations. The principles of the wave theory are outlined with particular reference to the case of rectangular rooms with slightly absorbing walls, and it is shown how a strictly exponential decay cannot be expected. Reference is made to applications of the wave theory to acoustic engineering problems and the psycho-physical aspects of the subject, such as "articulation index" are briefly mentioned. G. F. HODSMAN

OPTICS . RADIATION . SPECTRA 535

535.14 : 530.145

2290. The second radiation constant in Planck's radiation formula. G. A. W. RUTGERS. *Physica*, **15**, 985–9 (*Dec.*, 1949).

The radiant intensity of a black body at the Au point has been measured for 3 wavelengths. From these measurements a value of $c_2 = 1{\cdot}432_5 \pm 0{\cdot}002$ cm degree is derived. The max. luminosity factor was found to be 628 lm/W, corresponding to a value of $c_2 = 1{\cdot}431$ cm degree. A survey of experimental data shows that the difference between the results of radiation measurements and the calculated value of c_2 amounts to about 0·35%. A.

535.214 : 538.56

Torque and angular momentum of centimetre electromagnetic waves. *See Abstr.* 2587

535.222

2291. A measurement of the velocity of light. R. A. HOUSTOUN. Letter in *Nature, Lond.*, **164**, 1004 (*Dec.* 10, 1949).

Reports a value $c = 299\,775$ km/s *in vacuo* determined by the author's modified Fizeau method [*ibid.*, **142**, 833 (1938)]. G. F. LOTHIAN

535.23.08

2292. The theoretical and practical sensitivity of the pneumatic infra-red detector. M. J. E. GOLAY. *Rev. Sci. Instrum.*, **20**, 816–20 (*Nov.*, 1949).

Following an introductory sketch of the application of the pneumatic infrared detector to spectrometry, the absolute sensitivity of a pneumatic detector is calculated for the case of an infinitely extended flat heat cell. The calculated and experimental results are in good agreement. A.

535.23.08

2293. On the ultimate sensitivity and practical performance of radiation detectors. P. B. FELLGETT. *J. Opt. Soc. Amer.*, **39**, 970–6 (*Nov.*, 1949).

Recent work is reviewed and discussed. It is shown that the validity of Clark Jones's treatment [Abstr. 903 (1948)] is more restricted than was supposed. By an extension of his argument a general method is obtained giving the ultimate sensitivity throughout the region of the electromagnetic spectrum in which the limit is set by temp. radiation. It is found that Clark Jones's method, suitably interpreted, is a useful approximation in most practical cases. The method is applied to a number of detectors. The well-known result for the noise level in a radio aerial is confirmed. The performance of certain photo-multipliers and photoconductive i.r. cells is assessed. It is found that the sensitivities of recent PbTe cells closely approach the ultimate limit corresponding to room temp. Consequently, improvements to these cells cannot give rise to substantially increased sensitivity unless the cells are used in cooled enclosures. A.

535.231.4 : 537.311.3

Emissivity of titanium. *See Abstr.* 2448

535.24

2294. Theoretical foundations of photometry. S. O. MAĬZEL. *Izv. Akad. Nauk, SSSR, Otdel. Tekh. Nauk* (*No.* 9) 1274–83 (*Sept.*, 1949) *In Russian.*

A discussion of the relation of photometry to physical and physiological optics and radiation theory. B. F. KRAUS

535.243

2295. Spectrophotometry (200 to 1 000 millimicrons). K. S. GIBSON. *Circ. Nat. Bur. Stand., Wash.* (*No.* 484) 1–48 (1949).

A review of principles and instrumental methods. Defines a set of terms and symbols, those concerning absorption and transmission having been agreed upon by the N.B.S. as a compromise between the various existing terms. Definitions include in connection with (*a*) sources radiating energy-radiant flux, radiant intensity, radiance, irradiance and the luminous analogues of these; (*b*) transmission and absorption-transmittance, internal transmittance, absorbance, absorbance index, absorbancy index (or specific extinction); (*c*) spectral reflection-reflectance, specular reflectance and (directional) reflectivity. Representative, commercially produced, instruments described use as photometric means the photographic plate, eye or photocells, and for isolating wavelengths, prisms, gratings or filters. Methods of calibration are given, together with the effects of stray energy, temp. and fluorescence of the specimen, multiple reflections due to the specimen and finite slit widths. Data concerning useful standards are given—energy distribution of a Planckian radiator at 2 848°K (or 2 842° or 2 854° according to the value adopted for C_2); and absorbancy and transmittancy for various solutions. Standard glasses recommended for transmission and reflection are described. 127 references are given. G. F. LOTHIAN

535.243

2296. Spectroradiometry. F. J. STUDER AND W. R. JACOBSON. *Gen. Elect. Rev.*, **52**, 34–9 (*Oct.*, 1949).

After a brief survey of the principles and applications of spectroradiometry the authors describe two recording instruments. One is for precision work and employs a constant deviation spectrometer for dispersion. The other is for industrial work and employs a grating. In both instruments the detector is a multiplier photocell. Methods of use, calibration and applications are described. J. W. T. WALSH

535.243

2297. A continuous, automatic tristimulus integrator for use with the recording spectrophotometer. H. R. DAVIDSON AND L. W. IMM. *J. Opt. Soc. Amer.*, **39**, 942–4 (*Nov.*, 1949).

Selsyn transmitters mounted on the spectrophotometer relay the wavelength and reflectance to the computer where integration is carried out by means of mechanical analogue techniques. The integrations are performed continuously while the curve is being drawn at either fast or slow speed. Tristimulus values for any curve may, therefore, be obtained by the spectrophotometer operator with no additional expenditure of time other than that required to record the values and return the counters to zero. The precision of the prototype computer $\simeq \pm 0{\cdot}0005$ and the absolute accuracy of the tristimulus values obtained $\simeq \pm 0{\cdot}003$. A.

535.245 : 621.383 : 621.317.39

2298. A photoelectric brightness meter. Y. G. HURD. *Illum. Engng, N.Y.*, **44**, 555–7 (*Sept.*, 1949).

Describes a brightness meter with an angle of

ceptance of 2° (total). A Cs_2O photocell is mounted at one end of a blackened cylinder with internal baffles, and with the simple amplifier described, brightness down to about 16 cd/m² can be measured satisfactorily. J. W. T. WALSH (R)

535.249

2299. Measuring shadow and diffusion with the photoelectric meter. K. NORDEN. *Illum. Engng, N.Y.*, **44**, 607–11 (*Oct.*, 1949).

The results obtained when measuring penumbral shadows with a photocell depend on the dimensions of the sensitive surface. This effect is examined and it is shown that under ordinary conditions met with in practice the differences obtained by using cells of normal sizes are not important. Where a single source furnishes all the light the use of the largest type of cell normally incorporated in an illuminometer is recommended. J. W. T. WALSH

535.312

2300. The trapping of fluorescent light produced within objects of high geometrical symmetry. W. A. SHURCLIFF AND R. C. JONES. *J. Opt. Soc. Amer.*, **39**, 912–16 (*Nov.*, 1949).

In a fluorescent body (e.g. scintillation counter crystal for detecting nuclear radiation) some of the fluorescent light may be trapped within the body because it is totally internally reflected an indefinitely large number of times. This phenomenon occurs only in bodies whose shapes have high symmetry. Equations are derived for the trapping fractions of rectangular parallelepipeds, plane parallel sheets, and spheres. Illustrative numerical values are given for various values of refractive index. For rectangular parallelepipeds of index 1·225, 1·500 and 2·000, the trapping fractions are 0·0, 0·236 and 0·598 respectively. For a sphere of index 1·50, the trapping fraction is 0·414 or 0·264, depending on whether the index with respect to the exciting radiation is taken as 1·00 or 1·50, these alternatives corresponding essentially to excitation by γ-radiation or by light, respectively. A.

535.313.2

2301. An improved mirror for photography of the whole sky. C. E. DEPPERMANN. *Bull. Amer. Met. Soc.*, **30**, 282–5 (*Oct.*, 1949).

Describes previous photography of whole sky by a camera above a silvered globe and the disadvantages of the compression of the region near the horizon. Calculates the curvature of a mirror to reflect the whole sky as uniformly as possible. The proposed curve does not depart markedly from a circle, is practicable to construct and would be valuable for meteor work or airport records of the state of the sky. Useful references are appended. E. G. MARTIN

535.317.3

2302. Secondary color in optical relay systems. R. E. HOPKINS. *J. Opt. Soc. Amer.*, **39**, 919–21 (*Nov.*, 1949).

Secondary colour is usually a serious aberration in optical relay systems. It is shown that it can always be reduced to the tolerance but usually at the expense of increased field curvature. The theory shows that the field lenses should be made as large as possible. A.

535.317.5

2303. Study of the section of the diffraction solid in the presence of small third-order aberrations. A. MARÉCHAL AND G. PIEUCHARD. *C.R. Acad. Sci., Paris*, **229**, 999–1001 (*Nov.* 15, 1949) *In French.*

Using the results and symbols from a paper by Duffieux and Lansraux [Abstr. 606 (1947)] the authors deduce the intensity (E) in the image plane as a function of the different aberrations. Assuming that the image contrast is $\propto$ illumination at the centre of the diffraction field and a permissible reduction of illumination ($\Delta E/E$) of 0·1, then it follows that the max. spherical aberration is $0{\cdot}2\,\lambda$; also for a certain combination of aberrations the illumination is the same as for a perfect instrument. G. F. LOTHIAN

535.317.9

2304. Use of aspherical surfaces in the design of magnifiers for binocular vision. J. H. JEFFREE. Letter in *Nature, Lond.*, **164**, 1006 (*Dec.* 10, 1949).

It is suggested that coincidence of the two monocular fields of vision of low-power magnifiers is achieved by correcting coma for a stop position at the eyes of the observer. Correction of spherical aberration will further give freedom of eye-position. In practice a small amount of coma and spherical aberration must be tolerated in order to obtain the best compromise in the correction of field curvature and distortion. Such a lens is reported, having surfaces with paraxial radii 13 in and 3·25 in, of which the latter is ellipsoidal. A condition proposed by Coulman and Petrie is thereby satisfied [Abstr. 6868 (1949)]. H. H. HOPKINS

535.322.4

2305. A high index refractometer. A. H. PFUND. *J. Opt. Soc. Amer.*, **39**, 966–9 (*Nov.*, 1949).

A new refractometer is described, based on the principle of the penetration of light into the rarer medium at total reflection. A transparent hemisphere with a slightly curved diametral plane makes point contact with the smooth surface of the sample to be measured. When viewed through the hemispherical surface, Newton's black spot is visible. At the critical angle, the light is totally reflected at the hemisphere boundary, and the black spot disappears. The critical angle at which the spot is no longer seen can be translated into refractive index and measured with very simple equipment. Operation is unaffected by the index of a contact liquid and indices can be measured which are as high as the optical constants of the material available for the hemisphere. Measurements are described with a rutile hemisphere which renders the instrument useful to the index of the ordinary ray, $n = 2{\cdot}61$. A.

535.322.4

2306. Recording refractometer. H. E. JONES, L. E. ASHMAN AND E. E. STAHLY. *Analyt. Chem.*, **21**, 1470–4 (*Dec.*, 1949).

A continuous recording refractometer, designed and built for industrial control use, is satisfactory for both opaque and clear liquids. The sample stream flows continuously, and may be under pressure. Good stability has been achieved with a max. sensitivity of $\pm\,0{\cdot}00005$ refractive index unit. The

action depends on intensity of internal reflection, near the critical angle, in a prism in contact with the sample stream. A.

535.323

2307. Optical constants of calcite at low temperature. M. BARBARON. *C.R. Acad. Sci., Paris*, **229**, 875–6 (*Nov.* 2, 1949) *In French.*

Values of the refractive indices are given for the temp. range −200° to 18°C at wavelengths 5 790, 5 460 and 4 046 Å. R. F. BARROW

535.324 : 538.614

Magnetic double refraction of liquid mixtures. *See Abstr.* 2604

535.327

2308. Effect of temperature on density and refractive index. S. S. KURTZ, JR., S. AMON AND A. SANKIN. *Industr. Engng Chem.*, **42**, 174–6 (*Jan.*, 1950).

In order to emphasize the fact that the Eykman equation has a wide range of usefulness, the authors have summarized available data, including the data of Eykman, showing that the Eykman equation represents experimental data for the effect of temp. on the density and refractive index of organic compounds quite accurately over a wide range. A.

535.33.03

2309. Electrodeless discharge as light source for the spectral analysis of gases. S. E. FRISH AND E. YA. SHREĬDER. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13** (*No.* 4) 465–72 (1949) *In Russian.*

A 100 W push-pull valve generator was used as a source of electrical oscillations. The generator was connected to the outer electrodes of the discharge tube by means of a special coupling coil. By changing self-inductance and capacitance, the generator could be made to work from $\lambda = 9$ to 100 m. No effect of frequency on the nature of light could be detected. A method of quantitative spectral analysis of mixtures of gases is described, applicable also to cases when the discharge causes chemical change. Alternatively, an electrodeless ring discharge can be used for the analysis of gas mixtures. F. LACHMAN

535.33.03

2310. An air interrupter for use with the A.R.L. spark source. E. KACZOR AND K. CHAMBERLAIN. *J. Opt. Soc. Amer.*, **39**, 917–19 (*Nov.*, 1949).

535.33.03

2311. Characteristics of pulsed arcs in spectrochemical analysis. I. Zinc alloys. D. A. SINCLAIR. *J. Opt. Soc. Amer.*, **39**, 958–66 (*Nov.*, 1949).

A study has been made of the variations of some spectrochemically significant properties of pulsed arc discharges produced by a condensed arc source unit. Quantitative responses of sensitivities, line ratios and electrode heating to changes in pulse form have been determined. A.

535.33.072

2312. A Stark-effect microwave spectrograph of high sensitivity. K. B. MCAFEE, JR., R. H. HUGHES AND E. B. WILSON, JR. *Rev. Sci. Instrum.*, **20**, 821–6 (*Nov.*, 1949).

A microwave spectrograph is described in which the absorption of the gas being studied is modulated by the application of a periodic Stark-effect field so that the output of the crystal detector contains a radio frequency component which can be amplified with a narrow-band amplifier. By using a very narrow bandwidth, achieved by employing phase-sensitive detection, high sensitivity is obtained. The klystron is swept mechanically over the frequency range. Details of the components are given. A.

535.33.077

2313. Solar spectroscopy with a Cashman cell. R. R. MCMATH AND O. C. MOHLER. *J. Opt. Soc. Amer.*, **39**, 903–7 (*Nov.*, 1949).

A description is given of a long-focus all-reflecting spectrometer of the Pfund type which has been designed and constructed at the McMath–Hulbert Observatory for initial application to the i.r. solar spectrum. The detectors employed thus far are two Cashman cells that permit the recording of the solar spectrum between 1·0 μ and 3·6 μ with high resolution. Radiation from overlapping orders is effectively eliminated by a pre-dispersing unit. Two plane reflection gratings, ruled 600 lines/mm and 200 lines/mm, are used for the regions 1·0 μ–2·5 μ and 2·5 μ–3·6 μ respectively. Observed line separations indicate that approximately 80% of the theoretical resolving power has been attained. A.

535.33.072

2314. Spectroscopy in the 3 μ region of the infra-red spectrum. A. ELLIOTT, E. J. AMBROSE AND R. B. TEMPLE. *J. Sci. Instrum.*, **27**, 21–5 (*Jan.*, 1950).

An arrangement for spectroscopy in the 3 μ region is described which is particularly suited for measurement of small specimens of oriented materials with polarized radiation. The spectrometer is fitted with a PbSe cell, using radiation interrupted at 800 c/s. A magnified image of the specimen is projected on the spectrometer slit by a mirror arrangement, enabling specimens measuring 0·2 by 0·5 mm to be used. Several special techniques are described, including the use of evaporated Se to parabolize a spherical mirror. A.

535.33.072

2315. Pressure-tight infrared absorption cell for liquids. F. A. SMITH AND E. C. CREITZ. *Analyt. Chem.*, **21**, 1474–6 (*Dec.*, 1949).

The design and construction of tight cells are described, as well as the technique used in assembling and testing them. The cells have rock salt windows and were sealed with amalgam. They have been used at pressures up to 35 lb/in² gauge for recording the spectra, from 1 to 15 microns, of the butenes and 1,3-butadiene. The same cell serves also to prevent loss of volatile solvents from solutions during the recording of spectra. A.

535.331

2316. Oscillator strengths for various continua at the head of series in the spectra of Mg II and Si II. L. BIERMANN. *Nachr. Wiss. Göttingen* (*No.* 1) 12–13 (1947) *In German.*

The numerical accuracy achieved in these calculations [based on previous work in *Z. Astrophys.*, **22** 157 (1943) and *Nachr. Wiss. Göttingen* (*No.* 2) 116 (1946)] is estimated to suffice for all present astrophysical requirements. A. BEER

535.331

2317. Relative *gf* values for 335 lines of neutral vanadium. G. RIGHINI. *Mem. Soc. Astr. Ital.*, **20** *No.* 4) 303–13 (1949) *In Italian.*

Relative *gf* values for 335 lines of neutral V are obtained from the curves of growth theory of densities. A.

535.331

2318. Wave functions for Fe XIV. M. T. GOLD. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 4) 471–7 (1949).

The results obtained by Hartree's self-consistent field method, without exchange, for the radial wave functions of Fe XIV, for both the ground configuration ($3s^23p$) and the lowest lying configuration ($3s3p^2$) combining with the ground configuration, are presented. The level separation in the ground configuration of Fe XIV and the probability of spontaneous transition between these two levels are computed from these wave functions. The spontaneous-transition probability and the *f*-value for the transition array $3s3p^2 \rightarrow 3s^23p$ are also given. A.

535.331

2319. Excitation of the yellow doublet [and 3 302 Å doublet] of sodium by atomic hydrogen. R. AYNARD. *C.R. Acad. Sci., Paris*, **229**, 1069–71 (*Nov.* 21, 1949) *In French.*

The energy liberated in the formation of a molecule from 2 atoms of H (4·45 eV) must be absorbed by a third body. In the case of Na this may excite the D lines (2·09 eV) or the 3 302 Å doublet (3·8 eV), leaving H_2 with 5 or 1 quanta of vibration respectively. A condenser is discharged 50 times/sec through H and Na and by means of a synchronous shutter the spectrum is photographed at known times after the passage of the discharge. Both the above Na lines are observed. G. F. LOTHIAN

535.331

2320. Spark spectra of elements 43 and 61. D. L. TIMMA. *J. Opt. Soc. Amer.*, **39**, 898–902 (*Nov.*, 1949).

The ultraviolet spark spectra of elements of atomic numbers 43 and 61 were determined using U fission product materials. The limits of detectability and wavelength of the most sensitive lines are given for use in qualitative detection of these elements. A.

535.331

2321. Note on the arc spectrum of element 61. C. FELDMAN. Note in *J. Amer. Chem. Soc.*, **71**, 3841–2 (*Nov.*, 1949).

Details are given of the methods employed to obtain the spectrum of element 61, the chloride being used. The main lines observed are tabulated. A. HARVEY

535.331

2322. Structure of the mercury bands λ2540 and λ2476. S. MROZOWSKI. *Phys. Rev.*, **76**, 1714–16 (*Dec.* 1, 1949).

The structure of the band of Hg_2 at λ2540 and of the group of bands of Hg_2^+ at λ2476 was investigated under high dispersion. The band λ2540 was found to be limited by heads from both sides and to possess a number of sharp peaks on the long wavelength side. The bands at λ2476 were found to form a sequence with a gradually changing difference of the rotational constants of the upper and the lower energy states from negative to positive values. A number of peaks similar to those in λ2540 and band heads on both ends of bands are observed. An interpretation of the results is given in terms of the expected energy states of molecules of Hg_2 and Hg_2^+. A.

535.332

2323. The Stark effect in argon. I. L. MINNHAGEN. *Ark. Fys.*, **1**, *Paper* 20, 425–57 (1949).

Measurements on lines in the visible spectrum are made using the author's earlier arrangement [see Abstr. 2773 (1948)], and level displacements are deduced for a field of 100 kV/cm. Theoretical displacements are calculated assuming *jl* pair coupling, with electrostatic interactions between configurations treated as perturbations; agreement with the measurements is good, some remaining discrepancies being regarded as not serious. G. F. LOTHIAN

535.332

2324. Structure of the line λ4686 of He II. K. MURAKAWA, S. SUWA AND T. KAMEI. Letter in *Phys. Rev.*, **76**, 1721 (*Dec.* 1, 1949).

535.333

2325. Bond orders and vibration spectra of polyatomic molecules. G. B. BONINO AND E. SCROCCO. *Atti. Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **6**, 421–8 (*April*, 1949) *In Italian.*

The force-constants and bond orders of the C=O bond in 8 aldehydes and ketones are considered. R. F. BARROW

535.333

2326. Emission spectra of the diatomic halides of manganese. I. MnCl. P. TIRUVENGANNA RAO. *Indian J. Phys.*, **23**, 301–8 (*July*, 1949).

Violet-degraded and double-headed bands attributed to the diatomic molecule MnCl between λ3500–λ3900 have been photographed in emission in a heavy current discharge from a d.c. generator. They consist of 7 well-separated groups. A vibrational analysis is suggested on the basis that the system is due to the transition $^1\pi - {}^1\Sigma$ and a formula is derived. The Cl isotopic components are detected in the (1,0) sequence. The possibility of an electronic transition involving higher multiplicity terms is indicated. A.

535.333

2327. The emission spectrum of lead iodide. P. TIRUVENGANNA RAO. *Indian J. Phys.*, **23**, 321–9 (*July*, 1949).

An extensive system of bands, attributed to the diatomic molecule PbI in the visible region extending from λ6400–λ4350 has been obtained for the first time in an h.f. discharge. The bands are photographed with a Hilger constant deviation and a Fuess glass spectrograph. Some of the bands have sharp heads and are clearly degraded towards the red while some are diffuse and headless. About 130 bands in all could be measured and a quantum formula is derived from vibrational analysis. The intensity distribution in the system is analogous to that in the emission bands of PbCl. By analogy with the corresponding systems of the related halide molecules, the band system has been interpreted as due to the high frequency component of a $^2\Delta - {}^2\pi$ electronic transition. A.

535.333

2328. The near ultra-violet spectra of toluene. I. The absorption bands with particular reference to the new bands observed. M. R. PADHYE. *Indian J. Phys.*, **23**, 331–8 (*Aug.*, 1949).

The absorption spectrum of toluene has been studied between the temps. 0°C and 250°C and different initial vapour pressures. The main results are as follows: (1) The bands involve a combination of 2 or more quanta of vibrations in the ground state. (2) The intensity consideration leads to the classification of the band at 35 202 cm^{-1} as due to the excitation of a single quantum of vibration with frequency 2 273. Thus a new vibration frequency is proposed. (3) Some bands are classified as due to the excitation of the non-totally symmetrical frequencies not included in the analysis of previous workers. (4) A complete analysis of the already known absorption bands is also given and the results are discussed. A.

535.333

2329. The near ultra-violet spectra of toluene. II. The emission bands. R. K. ASUNDI AND M. R. PADHYE. *Indian J. Phys.*, **23**, 339–46 (*Aug.*, 1949).

An emission spectrum of toluene in the near u.v. is excited by a transformer discharge through flowing vapour. Most of the bands are those observed already in absorption but there are a few which have not been recorded in the absorption spectrum. A complete analysis of the emission bands which is in agreement with the one for absorption bands is proposed. The general appearance of bands and their intensities are compared with those of the corresponding emission bands of benzene. A fairly strong continuous emission band with a sharp short wavelength limit coinciding with the origin of the emission band system has also been recorded. A.

535.333

2330. New spectra of the molecule CsXe. G. THOMAS AND L. HERMAN. *C.R. Acad. Sci., Paris*, **229**, 1313–15 (*Dec.* 14, 1949) *In French.*

Continua associated with the lines of Cs I at 8 521, 4 593 and 4 555 Å are discussed. R. F. BARROW

535.333 : 523.77

2331. Carbon dioxide in the infra-red solar spectrum. L. GOLDBERG, O. C. MOHLER, R. R. MCMATH AND A. K. PIERCE. *Phys. Rev.*, **76**, 1848–58 (*Dec.* 15, 1949).

Wavelength measurements are given for lines in 13 vibration-rotation bands of CO_2 observed between 1·5 μ and 2·1 μ in the i.r. solar spectrum and in the laboratory. The observations were made with the McGregor spectrometer and Cashman cell of the McMath–Hulbert Observatory. Among the 13 bands, 7 originate from the ground state and 2 from the first excited state of $C^{12}O_2^{16}$. The remaining 4 are identified with ground state transitions in the isotopic molecules $C^{13}O_2^{16}$ and $C^{12}O^{16}O^{18}$. The rotational constants α_1, α_2 and α_3 have been determined from analysis of the rotational structures. The mean value found for B_{000} is 0·3906 cm^{-1} and for the equilibrium position $B_e = 0{\cdot}3920\ cm^{-1}$. A.

535.333 : 523.873

Bands of the molecule $C^{13}N^{14}$ in spectra of carbon stars. *See Abstr.* 2163

535.333

2332. Theory of doublet spectra under magnetic perturbation. S. SENGUPTA. *Indian J. Phys.*, **23**, 287–300 (*July*, 1949).

The problem of a spinning electron moving round the nucleus in the presence of an external magnetic field has been considered from the wave-statistical point of view. The general expressions for energies and wave functions in any field strength have been obtained. The problems of no field, weak field (Zeeman effect) and strong field (Paschen–Back effect) are considered as special cases. The results for the no field case are identical with those obtained in the earlier paper [Abstr. 5330 (1949)]. Other results also agree with the well-known spectroscopic formulae. A.

535.338.32

2333. The near ultra-violet spectra of benzene. III. Fermi resonance in the emission spectrum of benzene. R. K. ASUNDI AND M. R. PADHYE. *Indian J. Phys.*, **23**, 281–6 (*July*, 1949).

A large number of Fermi doublets have been discovered in the emission spectrum of benzene. These are due to accidental degeneracy in the vibrations 1 596 e_g^+ and 1 598 e_g^+ (combination of 606 e_g^+ + 922 a_{1g}) further superposed by several quanta of 992 a_{1g} vibration and involving also 923 a_{1g} excited frequency in addition to series of 160 difference frequency. The magnitude of doublet interval with increasing excitation of the vibrations is well represented by an expression derivable from considerations of the first order perturbation in the potential function of the molecule. A.

535.338.32

2334. The detection of magnetic resonance of excited levels: depolarization effect of optical resonance and fluorescence radiations. J. BROSSEL AND A. KASTLER. *C.R. Acad. Sci., Paris*, **229**, 1213–15 (*Dec.* 5, 1949) *In French.*

A technique is described whereby excited levels arising from the influence of a magnetic field can be detected through study of linear or circular depolarization effects. W. R. ANGUS

535.338.332

2335. On the investigation of the fine structure of the hydrogen spectrum by a radioresonance method. A. LUBNY-GERTSYK. Letter in *J. Exp. Theor. Phys., USSR*, **19**, 950 (*Oct.*, 1949) *In Russian.*

Suggests that irradiation of an H_2 discharge with 1 m radio-waves should induce $3S_{\frac{1}{2}} \leftrightarrow 3P_{\frac{1}{2}}$ transitions and alter the intensity of emission, since the $3S_{\frac{1}{2}}$ state emits to give a red line and a $2P$ state while the $3P_{\frac{1}{2}}$ state emits a u.v. line and returns the atom to the ground state. The change of emission on irradiation with the resonance frequency should be detectable with a photocell, if modulation of the h.f. source is employed and the term splitting thus measured.

D. H. WHIFFEN

535.338.332

2336. Hyperfine structure in the band spectrum of the mercury hydride HgH. S. MROZOWSKI. *Phys. Rev.*, **76**, 1820–6 (*Dec.* 15, 1949).

535.338.332 : 539.152.1

2337. Hyperfine structure of Fe 57. J. BROSSEL. Letter in *Phys. Rev.*, **76,** 858–9 (*Sept.* 15, 1949).

No structure, broadening or asymmetry was found in the 400 lines examined [compare the similar results for Ni 61; Abstr. 428 (1950)]. Measurements of some accidentally coinciding lines in Fe I are reported.

R. F. BARROW

535.338.4

2338. A new spectrum of OD in the visible region. H. SCHÜLER AND L. REINEBECK. *Z. Naturforsch.*, **4a,** 560–1 (*Oct.*, 1949) *In German.*

Ten bands, degraded to the red, have been observed in the region 4 180–5 475 Å in emission from a glow-discharge in D_2O vapour. Like the bands already observed in H_2O [Schüler and Woeldike, *Phys. Z.*, **44,** 335 (1943)] they show a simple two-branch structure. The emitters are now considered to be neutral or charged OH and OD, as discharges in H_2O and D_2O mixtures yield no new spectrum of an HDO molecule.

R. F. BARROW

535.338.4

2339. Emission of atmospheric bands of the O_2 molecule. R. HERMAN AND L. HERMAN. *C.R. Acad. Sci., Paris,* **229,** 931–5 (*Nov.* 7, 1949) *In French.*

The emission spectrum of O_2 diluted with rare gases shows the $A^1\Sigma_g^+ - X^3\Sigma_g^-$ system in the i.r. With He, the second negative bands of O_2^+ are very strong at low partial pressure of O_2 and many new bands are obtained; at high partial pressure there is a continuum in the u.v. With Xe only the i.r. bands, forbidden lines of O I at 5 577 and 2 972, and a continuum from 2 400 to shorter λ are observed.

A. G. GAYDON

535.343

2340. The temperature variation of an absorption spectrum. A. HERCZOG AND K. WIELAND. *Helv. Phys. Acta,* **22** (*No.* 5) 552–4 (1949) *In German.*

The suggestion [Abstr. 1406 (1950)] that the linear relationships obtained by plotting temp. against wavelength for constant absorption coeffs. [Abstr. 4651 (1949)] can be extrapolated to the absolute zero is shown to be inapplicable to Cl.

R. A. WEALE

535.343

2341. New band spectra of the diatomic halides of lead. K. WIELAND AND R. NEWBURGH. *Helv. Phys. Acta,* **22** (*No.* 6) 590–1 (1949) *In German.*

Vibrational analyses of absorption systems are reported. The following constants have been derived:

$PbCl^{35}$: $\nu = 35\,199 + 382{\cdot}1\,u' - 1{\cdot}05u'^2 - 304{\cdot}2u'' + 0{\cdot}89\,u''^2$.

$PbBr^{79}$: $\nu = 34\,523 + 258{\cdot}2\,u' - 0{\cdot}6\,u'^2 - 207{\cdot}5\,u'' + 0{\cdot}5\,u''^2$.

PbI: $\nu = 33\,488 + 198{\cdot}7\,u' - 0{\cdot}35\,u'^2 - 160{\cdot}5\,u'' + 0{\cdot}25\,u''^2$.

PbI: $\nu = 20\,528{\cdot}5 + 142{\cdot}0\,u' - 1{\cdot}5\,u'^2 - 160{\cdot}5\,u'' + 0{\cdot}25\,u''^2$,

where $u = v + \frac{1}{2}$. Predissociation is observed in the first 3 systems, and the following values of the dissociation energies, D_0'' are deduced: PbF: 80·0; PbCl: 72·0; PbBr: 68·5; PbI: 65·5 k.cal/mole.

R. F. BARROW

535.343

2342. Use of thin films of sublimate for absorption spectroscopy. R. L. SINSHEIMER, J. F. SCOTT AND J. R. LOOFBOUROW. Letter in *Nature, Lond.*, **164,** 796–7 (*Nov.* 5, 1949).

The u.v. absorption spectrum of thin films of uracil undergoes marked changes with time when the films are left standing at room temp. under laboratory conditions: the fine structure, barely noticeable in a new film, gradually appears, but tends to disappear after 6 months when the film turns cloudy. Solutions in buffer of this material (and others similarly affected) show no change, indicating that no molecular decomposition has occurred. Films kept *in vacuo* or in a dry atmosphere do not change. After 7 days standing the i.r. absorption spectrum shows a narrowing and intensification of the bands, accompanied by better resolution. Explanations of these changes are advanced, and two illustrations given.

R. A. WEALE

535.343 : 539.132

2343. Vibration-rotation bands of some polyatomic molecules. A. R. H. COLE AND H. W. THOMPSON. *Proc. Roy. Soc. A,* **200,** 10–20 (*Dec.* 22, 1949).

The rotational structures of some vibrational absorption bands of vinyl chloride, vinyl fluoride, vinylidene fluoride and glyoxal have been measured with high dispersion. An analysis of bands of different types has been carried out in order to test vibrational assignments and to correlate the observed rotational structure with the molecular geometry. An ambiguity in the allocation of vibration frequencies of vinyl fluoride has been removed, and the frequencies for the different vinyl halides have been correlated with each other. Glyoxal has been shown to possess the *trans* structure, in agreement with conclusions based on other physical measurements.

A.

535.343.2

2344. Vibration spectrum of the H-bond. E. F. GROSS AND V. I. VALKOV. *Dokl. Akad. Nauk, SSSR,* **68** (*No.* 3) 473–6 (1949) *In Russian.*

Dispersion spectra of $CaSO_4 . 2H_2O$, $KAl(SO_4)_2 . 12H_2O$, $MgCl_2 . 6H_2O$ crystals show a group of sharp lines near 200 cm^{-1} corresponding to broader bands in their solutions. Strongest line of greatest frequency is H bond ground vibration. O–H line near 3 600–3 200 cm^{-1} is a broad band; if this is not excited, H vibrations are strongly anharmonic. H bond dissociation energies are 4·5, 5, 2·1 cal/mole respectively. The results favour the predissociation rather than the fluctuation theory of the H bond.

J. JACOBS

535.343.2–31

2345. The far ultra-violet absorption spectra of some optical materials. A. GILLES, R. BAUPLÉ, J. ROMAND AND B. VODAR. *C.R. Acad. Sci., Paris,* **229,** 876–8 (*Nov.* 2, 1949) *In French.*

Figures are given of the extinction coefficients, of samples of quartz, corundum, CaF_2 and LiF for wavelengths down to 1 500 Å.

R. F. BARROW

535.343.3

2346. Absorption spectra, molecular weights and visual purple. R. WEALE. Letter in *Nature, Lond.*, **164,** 959–60 (*Dec.* 3, 1949).

The reason for the disagreement between Collins

and Morton's [Abstr. 1408 (1950)] and Weale's [Abstr. 5827 (1949)] calculations from the absorption spectrum of haemoglobin is revealed, the difference between two values for the carrier weight of visual purple pointed out, and Hecht and Pickels' value for the molecular weight of visual purple rejected as being very doubtful. The value (270 000) was obtained with the ultra-centrifuge, digitonin being the detergent used. When digitonin was ultra-centrifuged its micellar weight was found to be 75 000, and might be as high as 400 000: its m.w. is 1 228. R. A. WEALE

535.343.4

2347. The temperature dependence of the overall absorption of iodine vapour. P. SULZER AND K. WIELAND. *Helv. Phys. Acta*, **22** (*No.* 6) 591–3 (1949) *In German.*

Measurements of the overall light absorption in the region 4 000–9 000 Å are given for the range 400–1 200°K. The absorption increases with increasing temp. R. F. BARROW

535.343.4–14

2348. The Paschen–Back effect in NH_3 and N_2O microwave spectra. C. K. JEN. *Phys. Rev.*, **76**, 1494–501 (*Nov.* 15, 1949).

The effect has been investigated with a resonant cavity spectroscope. The molecules are known to possess relatively small values of nuclear electric quadrupole coupling and thus favour the realization of the effect without prohibitively high magnetic fields. The results for $N^{14}H_3$, representing a case of one-nuclear (N^{14}) coupling, show the effects of gradual decoupling of the nuclear spin from molecular rotation. The existence of the "forbidden" lines, whose intensities diminish with increasing field, indicates that the decoupling is not quite complete even in a field of 10 000 oersteds. The results for, $N^{14}N^{14}O^{16}$, representing a case of two-nuclear (N^{14}, N^{14}) coupling, show that the decoupling is almost complete at a field of 10 000 oersteds. An asymmetry of the Paschen–Back pattern for a $\Delta J \neq 0$ transition is ascribed to the non-linear dependence of the nuclear quadrupole coupling energy upon M_J and M_I. The measured results are found to be in good agreement with quantum mechanical calculations. Also, consistent with the theory of the structure of the Paschen–Back pattern, it is shown that the molecular g-factors and the nuclear quadrupole coupling factors can be determined directly from experimental data. A.

535.343.4–14

2349. Inversion spectrum of ammonia. A. H. SHARBAUGH, T. C. MADISON AND J. K. BRAGG. Letter in *Phys. Rev.*, **76**, 1529 (*Nov.* 15, 1949).

A Stark modulation spectrograph with a 1 ft absorption cell showed 37 new lines. These have been identified, and all lines now satisfy an empirical formula including 6th power terms. J. JACOBS

535.343.4–15

2350. Pressure dependence of line width in infra-red spectra. F. MATOSSI. *Phys. Rev.*, **76**, 1845–7 (*Dec.* 15, 1949).

The effect of coupling of molecular vibrations on line width in i.r. spectra is dealt with. Line widths due to this effect are $\propto$ the square root of pressure. Numerical discussion indicates that at least part of the line width in water-vapour spectra can be ascribed to this effect. A.

535.345 : 537.311.33

2351. Optical properties of semiconductors. I. The reflectivity of germanium semiconductors. K. LARK-HOROVITZ AND K. W. MEISSNER. Letter in *Phys. Rev.* **76**, 1530 (*Nov.* 15, 1949).

Ge alloys of *N*- and *P*-type with a small concentration of charge carriers, $\sim 10^{16}$ per cm^3 and a larger number, 5×10^{18} per cm^3 were investigated. From 0·6 μ to 12 μ a rock salt spectrometer and Nernst filament as radiation source were used and the reflectivity determined by comparison with an Al mirror. From 0·6 μ to 0·8 μ the reflectivity of all samples is between 47 and 51%. This decreases and remains constant at 35% up to 40 μ. From 8·7 μ to 152 μ the method of residual rays was used in the form described by Strong [*ibid.*, 37, 1565 (1931)]. Radiations of wavelengths 8·7, 20, 30, 41, 52, 117 and 152 μ could be selected. High conductivity samples show a high reflectivity at 117 μ which decreases again at 152 μ but is still > the reflectivity of the high resistivity samples, which remains essentially constant throughout the whole range of wavelength. The highest reflectivity recorded is 81% at 117 μ. C. A. HOGARTH

535.345 : 537.311.33

2352. Optical properties of semiconductors. II. Infra-red transmission of germanium. M. BECKER AND H. Y. FAN. Letter in *Phys. Rev.*, **76**, 1530–1 (*Nov.* 15, 1949).

Bulk material of Ge several cm thick gives appreciable transmission over broad regions of the i.r. spectrum. Transmission measurements were made with a Gaertner rock-salt monochromator, using 3 samples of *N*-type Ge (ρ = 5 ohm cm for single crystal from which specimens were cut) of thickness 0·26, 0·77 and 3·45 mm and for which each surface was optically polished. At wavelengths where the absorption is small and transmission is determined primarily by surface reflections there is no irregular variation of transmission for the different samples, i.e. reflectivity is constant. Ge absorbs little from 12 μ to 2 μ, but the absorption coeff. increases rapidly below 2 μ. A reflectivity of 35% is assumed for the specimens in calculating results and this value is justified from the consistency of results and by the reflectivity experiments of Abstr. 2351 (1950). Similar results were obtained for specimens of about the same resistivity but from different melts. For specimens of lower resistivity (0·015 ohm cm) which are known to be polycrystalline the absorption is much higher although the reflectivity is still about 35%. From 3 μ to 12 μ the absorption coeff. increases from 0·5 to 3 for low ρ and from 0·1 to 0·5 for high ρ Ge. C. A. HOGARTH

535.345 : 537.311.33

2353. Optical properties of semiconductors. III. Infra-red transmission of silicon. M. BECKER AND H. Y. FAN. Letter in *Phys. Rev.*, **76**, 1531–2 (*Nov.* 15, 1949).

Using similar experimental arrangement to that for Ge [preceding Abstr.] measurements were made on low-resistivity (ρ = 0·03 ohm cm) *P*-type Si from liquid air temp. to 380°C. Reflectivity, R = 0·27 is

agreement with earlier work by Lark-Horovitz nd Meissner. The absorption decreases with temp. ver the whole spectrum covered by the measurements ·8 to 2·6 μ). The absorption coeff. is about 3 cm^{-1} at 1·2 μ and room temp., increasing slowly ith increasing wavelength and rapidly with decreasing avelength from this value. The sharp increase in bsorption for both Ge and Si is apparently due to uantum transitions from the filled to the conduction and. The absorption band begins at about the avelength calculated from the activation energy for trinsic conduction in both Ge and Si. The absorpon calculated from the Drude–Zener theory for avelengths > that required for excitation between ands, is ≪ that observed experimentally, and this act is not explained. C. A. HOGARTH

535.347 : 539.133

354. On the calculation of molecular dichroism. . NIKITINE. *Helv. Phys. Acta*, **22** (*No.* 6) 595–8 1949) *In French.*

The single transition moment M is replaced by the um $\Sigma_k M_k$, from each bond k, in molecules conaining chains of resonating double bonds. The *is-*, *trans-*, or mixed isomers have absorption bands lightly displaced, explaining variation of dichroism n one absorption band as observed. Changes in nolecular vibrations which may affect dichroism re ignored. J. JACOBS

535.37

355. A particular case of inhibition of fluorescence. . BANDERET. *Helv. Phys. Acta*, **22** (*No.* 6) 593–5 1949) *In French.*

Contrary to a previous supposition, the curves of luorescent intensity $v.$ concentration, when an nhibitor of long chain feebly dissociated molecules s added to a solution of a dyestuff, are now found to e explained by the formation of a new substance.

J. EWLES

535.371

356. Some new complex silicate phosphors containing calcium, magnesium, and beryllium. A. L. SMITH. *J. Electrochem. Soc.*, **96**, 287–96 (*Nov.*, 1949).

535.371

357. The luminescence of photo-conducting phosphors. G. F. J. GARLICK AND A. F. GIBSON. *J. Opt. Soc. Amer.*, **39**, 935–41 (*Nov.*, 1949).

Studies have been made of the effects of nonradiative loss of the energy absorbed by phosphors which occur when excitation frees electrons from luminescence centres in the phosphors so that they move freely in the matrix crystal. Such non-radiative losses also occur at elevated temps. when the thermal energy of the phosphor is sufficient to free electrons from the excited states of the emission centres. These processes give rise to a non-linear variation of the luminescence intensity with the intensity of excitation, as observed by previous workers. In addition to more exhaustive studies of this non-linear behaviour of the luminescence, studies have been made of the semiconduction, photo-conduction and thermoelectric effects in phosphors at temps. where the non-radiative processes are present. These electrical measurements show that at elevated temps. phosphors behave as excess semi-conductors, that is, the observed current is due mainly to electrons and not to positive hole motion, as assumed by some previous workers. The investigations provide a qualitative explanation of the low efficiency of excitation of phosphors by particles or high energy quanta. They show that for excitation by u.v. light of wavelength > that of the fundamental absorption edge of the phosphor matrix (ZnS phosphors), the electrons excited do not leave the neighbourhood of the emission centres and only give rise to transient photoconductivity effects having the nature of displacement currents. A.

535.371

2358. The luminscence characteristics of tin-activated zinc sulphide phosphors. G. F. J. GARLICK AND D. E. MASON. *Proc. Phys. Soc. Lond. A*, **62**, 817–22 (*Dec.*, 1949).

It has been found that the inclusion of stannous compounds in relatively large concentrations in the preparation of ZnS phosphors results in an intense red luminescence when excitation is by u.v. light of long wavelength (3 650–4 000 Å). Such characteristics as the luminescence spectra, excitation spectra, phosphorescence and thermoluminescence and the variation of luminescence with temp. have been studied. The hexagonal crystal form of ZnS is essential to the production of efficient phosphors with tin as the activating impurity. A.

535.371.096

2359. The influence of temperature on the efficiencies of zinc sulfide phosphors containing silver and cobalt. C. G. A. HILL AND H. A. KLASENS. *J. Electrochem. Soc.*, **96**, 275–86 (*Nov.*, 1949).

The temp.-dependence of the blue fluorescence of ZnS phosphors containing 10^{-2}% Ag and 0–10^{-3}% Co, under λ3650 excitation, has been measured over the temperature range of 120–600°K. The form of the curve and its shift toward lower temperatures on the introduction of Co are interpreted in terms of the theory of hole migration. The activation energy for hole migration from Ag luminescence centres is found to be 0·36 ± 0·02 eV. An estimate of the number of intrinsic killer centres in terms of Co centres is obtained. A.

535.372

2360. Phosphorescent spectra of benzol and its methyl substitutes. P. P. DIKUN AND B. YA. SVESHNIKOV. *J. Exp. Theor. Phys.*, **19**, 1000–20 (*Nov.*, 1949) *In Russian.*

535.375.5

2361. The polarization of the spectrum of second order scattering by a crystal of rock salt. E. F. GROSS, P. P. PAVINSKIĬ AND A. I. STEKHANOV. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 1) 27–30 (1949) *In Russian.*

The T^n proportionality law for the temperature-dependence of nth order scattering [Abstr. 3845 (1948)] was experimentally confirmed for $n = 2$, except in the region 60–200 cm^{-1} where the 2nd order scattering was partially masked by other effects. The 2nd-order spectrum from NaCl at 500°c was found to be polarized, the component with electric vector ⊥ to the incident beam resembling the spectrum obtained at high temps. with non-polarized light and the || component like that with non-polarized light at low temps. The range 60–200 cm^{-1} is also anomalous in being the most polarized region. An explanation,

based on the symmetry which the cubic structure imposes on long wave oscillations, is outlined.

A. L. MACKAY

535.375.5

2362. Infra-red and Raman spectra of hexachloroethane. S. MIZUSHIMA, Y. MORINO, T. SIMANOUTI AND K. KURATANI. Letter in *J. Chem. Phys.*, **17**, 838–9 (*Sept.*, 1949).

The absorption spectra (8–16 μ) were observed for solid and for solutions of C_2Cl_6 in CCl_4 and also the Raman spectrum of solid C_2Cl_6. Observed and calculated fundamental *νν* are in agreement with the staggered D_{3d} form, a conclusion which substantiates the authors' electron diffraction investigation. It is shown that the Urey–Bradley field adequately supplies a potential function for the treatment of the normal vibration of the molecule. W. R. ANGUS

535.375.5

2363. Raman spectrum of rocksalt. H. L. WELSH, M. F. CRAWFORD and W. J. STAPLE. *Nature, Lond.*, **164**, 737–8 (*Oct.* 29, 1949).

The curve of intensity distribution in the spectrum of rocksalt has been obtained by an experimental arrangement which is described and reveals that the Raman spectrum of rocksalt consists of a continuum with superimposed maxima of small intensity relative to the continuum. This and other features cannot be interpreted by the Raman theory, but qualitatively the intensity contour confirms the theory of Born.

W. R. ANGUS

535.375.5

2364. New studies on the influence of conjugation on the intensity of Raman lines. M. HARRAND. *C.R. Acad. Sci., Paris*, **229**, 1217–18 (*Dec.* 5, 1949) *In French.*

Comparison of the spectra of Ph . CH_2 . CH_2 . CHO, Ph . CH : CH . CHO, Ph . C : C—CHO, CH_3 . CH: CH . CHO and CH_3 . CH_2 . CH_2 . CHO reveal striking influences of conjugation on the intensities of Raman lines in agreement with earlier observations on hydrocarbons. [Abstr. 185 (1949)]. W. R. ANGUS

535.375.5

2365. Relative intensities in the Raman spectra of some Group IV tetrahalides. L. A. WOODWARD AND D. A. LONG. *Trans. Faraday Soc.*, **45**, 1131–41 (*Dec.*, 1949).

Considerations based on the Placzek theory show that, when the usual Wood's tube method of Raman excitation is used, the calculation of relative mean derived polarizabilities *a* from observed relative Raman intensities is only possible for specially selected molecules and vibrational modes. The Group IV tetrahalides and their symmetrical breathing modes satisfy the requisite conditions. Values of *a* for a number of these compounds are deduced from the corresponding Raman intensities, as determined relative to CCl_4 by photographic photometry of the spectra of suitable binary mixtures. The results are quite at variance with the assumption, previously made by Hansen–Damaschun, that *a* is simply ∝ the degree of covalent character of the bond involved. The measured values for the typical and Group IVB tetrahalides XY_4 conform approximately to the simple empirical rule that *a* is ∝ the product of (i) the sum of the atomic numbers of X and and (ii) the percentage covalency of the X—Y link obtained by Pauling's relation from the electro negativities. $TiCl_4$, the only Group IVA compoun investigated, does not obey the rule.

535.375

2366. Vibration spectrum and structure of potassiu bicarbonate. L. COUTURE-MATHIEU. *C.R. Aca Sci., Paris*, **229**, 1215–16 (*Dec.* 5, 1949) *In French.*

Raman spectral data on a single crystal of KHC differ considerably from data on neutral ionic ca bonates and lead to the conclusion that the cryst does not contain HCO_3^- ions; instead, CO_3^{--} ion linked together by H-bonds, form chains parall to the binary axis of the crystal. Each K^+ ion surrounded by 8 O atoms. W. R. ANGU

535.375.5 : 545.8

2367. Raman spectra as analytical aids. J. GOUBEAU *Z. angew. Phys.*, **1** (*No.* 3) 146–52 (1948) *In German.*

A general review of the measurement of Rama spectra and of their application qualitatively an quantitatively in analysis. W. R. ANGU

535.3

2368. The formation of reflection-reducing surfac layers on glass by the use of solutions of *p*H about H. SCHRÖDER. *Z. Naturforsch.*, **4a**, 515–21 (*Oct* 1949) *In German.*

Unlike concentrated acids, nearly neutral solution destroy also the silicate component of most glasses The kinetics of the process is described, and factor affecting it, like the temp. of the solution and th method of polishing the glass, are examined. Th suitability of the method for the reduction of th reflectivity particularly of large surfaces like window panes is discussed. Graphs are given. R. A. WEALI

535.3

2369. Reflection and transmission formulas for film on a backing plate. F. MATOSSI. *J. Opt. Soc Amer.*, **39**, 928–9 (*Nov.*, 1949).

Explicit formulae for reflection and transmissio for a film on a backing plate are derived for any angl of incidence. Film and plate material are assumed t be absorbing, the film being plane-parallel, the plat not plane-parallel. Only radiation with the electri vector vibrating perpendicular to the plane of inci dence is considered. A

535.39

2370. Spectral transmission of thin films of metals IV. Bismuth, antimony and arsenic. Y. SOEZIMA *J. Sci. Res. Inst., Tokyo*, **44**, 63–7 (*Nov.*, 1949).

535.39

2371. Spectral transmission of thin films of metals V. Tellurium and selenium. Y. SOEZIMA. *J. Sci Res. Inst., Tokyo*, **44**, 68–70 (*Nov.*, 1949).

535.39

2372. Spectral transmission of thin films of metals VI. Thallium and aluminium. Y. SOEZIMA. *J. Sci Res. Inst., Tokyo*, **44**, 71–3 (*Nov.*, 1949).

535.39

2373. A theory of emissivity and reflectivity R. A. WEALE. Letter in *Proc. Phys. Soc. Lond. A* **62**, 661–2 (*Oct.*, 1949).

Price's theory [Abstr. 3071 (1949)] is criticize because it accounts for neither the observed temp

ciation nor the wavelength variation of the optical nstants of metals. An X-point is inherent to the ssical dispersion formula; a table shows the agree- nt existing between observed and calculated lues when the Mott–Zener [*Proc. Camb. Phil. c.*, **30**, 249 (1934)] formulae are made the basis of e calculation [see Abstr. 935 (1948)]. R. A. WEALE

535.393

74. A theory of emissivity and reflectivity. D. J. ICE. Letter in *Proc. Phys. Soc. Lond. A*, **62**, 663 *Oct.*, 1949).

The validity of Weale's criticisms [preceding Abstr.] the author's theory [Abstr. 3071 (1949)] is ques- oned. The agreement between Kent's [*Phys. Rev.*, , 459 (1919)] results on the optical constants of quid metals and theory is ascribed to an additional rm in the expression for the metallic dielectric onstant which is said to be absent from Mott and ener's expression. Supposed differences in con- tions are pointed out under which true and spurious -points occur. R. A. WEALE

535.393

375. Reflectivity measurements on sanded alu- inium. J. EULER. *Z. angew. Phys.*, **1**, 569–73 *Dec.*, 1949) *In German.*

The variation with wavelength between 1 and 6 μ the diffuse reflectivity of sanded Al surfaces is xamined, as are the effects of different angles of cidence and reflection (β). The influence of grain ze, impurities and mechanical damage is mentioned. trongly sanded surfaces (grain size $\simeq 70\,\mu$) are ited for standard work, though relatively sensitive the latter two defects. Atmospheric corrosion roved immeasurably small after 2 y. For the arse surfaces Lambert's Law is obeyed fairly well hen $\beta \not> 35°$. A diagram of the spectroscopic pparatus and graphs are given. R. A. WEALE

535.417 : 523.77

High-resolution interferometry of the solar spectrum. *ee Abstr.* 2145

535.417 : 535.339

376. Use of the Fabry–Pérot etalon for the wave- ngth calibration of monochromators. F. DESVIGNES. *R. Acad. Sci., Paris*, **229**, 1001–3 (*Nov.* 15, 1949) *n French.*

The author considers the conditions required for ccurate calibration by "Edser–Butler" fringes and ives expressions for the fringe width ($\delta\lambda$), fringe eparation ($\Delta\lambda$), etalon transmission, and wavelength rror (ε) due to variation of detector-response with avelength, as functions of etalon thickness (e) and late reflection (r). A flint prism monochromator is alibrated up to $\lambda = 2\,\mu$ using an etalon with $= 18{\cdot}2\,\mu$ and $r = 0{\cdot}7$; the receiver response aried by a factor of not more than 3 from one fringe nax. to the next, giving $\varepsilon \leqslant 0{\cdot}018\,\Delta\lambda$. $\delta\lambda/\Delta\lambda$ was qual to 0·057. The calibration obtained agreed ith direct measurement of Hg and K lines to the xperimental error of about 1 mμ. G. F. LOTHIAN

535.42

377. On the general laws of diffraction. Critical eport. G. TORALDO DI FRANCIA. *Rev. Opt. (Théor. nstrum.)* **28**, 597–611 (*Nov.*, 1949) *In French.*

Reviews the classical principles of Huyghens, Fresnel, Kirchoff and the electromagnetic work of Sommerfeld and Mie. The author prefers that form of Huyghens' principle due to Luneberg [*Mathematical theory of optics* (1944)] which always permits solution for points distant from a diffracting screen. He explains the applications of his principle of "inverse interference" that "a given distribution of complex amplitude at the exit face of a screen gives rise to an assembly of diffracted waves which, propagated in the inverse direction would be capable of generating the initial amplitude distribution." One consequence of this is the existence of *ondes evanéscentes* best known in the phenomenon of total reflection. In general, diffraction is not thermodynamically reversible. 52 literature references are given. G. F. LOTHIAN

535.42

2378. Fraunhofer diffraction patterns of squares and rectangles. E. S. LAMAR. *J. Opt. Soc. Amer.*, **39**, 929–34 (*Nov.*, 1949).

The Fraunhofer diffraction patterns of a basic set of squares and rectangles have been computed by summation. The resulting tables are presented and methods are described for building up more complicated diffraction patterns in terms of this set. The limited nature of each table introduces systematic errors for large objects. These errors are discussed and estimates of their magnitudes are given for particular cases by comparison with those cases for which analytical solutions are available. A.

535.422

2379. Diffraction associated with defocusing. E. WOLF. Letter in *Nature, Lond.*, **164**, 924 (*Nov.* 26, 1949).

Assuming a spherical wavefront and a circular aperture, the author quotes formulae, to be derived elsewhere, for the fraction of light falling outside a circle of radius r in a plane distant Δf from the focal plane. The equations permit calculation of the light scattered by diffraction in refracting telescopes, taking account of the secondary spectrum.

G. F. LOTHIAN

535.43

2380. Equipment for measuring light scattering. M. BIER AND F. F. NORD. Letter in *Rev. Sci. Instrum.*, **20**, 752 (*Oct.*, 1949).

Briefly describes equipment for investigating state of aggregation by light scattering—(1) A photoelectric photometer to measure the intensities of Hg light ($\lambda = 4\,358$ Å) transmitted, and scattered at 45°, 90° and 135°. (2) A differential refractometer which measures the deviation of a monochromatic beam in passing through a rectangular cell, diagonally divided, the two halves containing solution and solvent respectively; sensitivity is $\Delta\mu = \pm 2\times10^{-6}$.

G. F. LOTHIAN

535.435

2381. The quadratic term in the light-scattering equation. S. N. TIMASHEFF, M. BIER AND F. F. NORD. *J. Phys. Coll. Chem.*, **53**, 1134–6 (*Oct.*, 1949).

The relation between turbidity (τ) and osmotic pressure (π), established by Debye [Abstr. 1502 (1947)], has been converted through partial molal free energy to the form $Hc/\tau = 1/M + 2Bc +$

$3Dc^2 + \ldots$, where M is the mol. wt., and B and D are related to the partial molal volume of solvent. Plots of Hc/τ against c for aqueous solutions of various fractions of polyvinyl alcohol-acetate copolymers at different temps. show marked upward curvature. A linear relationship is obtained by applying a corrective term containing c^2. W. R. ANGUS

535.435

2382. Intensity of the scattered light of the central component of the Rayleigh triplet. Y. ROCARD. *C.R. Acad. Sci., Paris*, **229**, 1137–9 (*Nov.* 28, 1949) *In French.*

Rayleigh scattering in liquids is some 10% stronger than theory predicts. The latter is improved by inclusion of fluctuation correlations between neighbouring elements. A form of the potential $\phi(r)$ of a molecule at a distance r corrected for effect of remaining fluid is given. Nearest neighbour interaction only is considered, a London r^{-7} law of force is assumed. The factor multiplying the Rayleigh R to account for slow density fluctuations is calculated as 1·16 for C_6H_6 at 10°C. This form of ϕ also leads to an improved equation of state for fluids. J. JACOBS

535.435

2383. The scattering cross section of water drops in air for visible light. H. G. HOUGHTON AND W. R. CHALKER. *J. Opt. Soc. Amer.*, **39**, 955–7 (*Nov.*, 1950).

Additional values of the scattering cross-section of water drops in air have been computed from the theory of Mie. The water drops are assumed to be dielectric spheres of index of refraction 4/3. Values of the scattering area coeff. have been computed for 50 values of $\alpha = 2\pi r/\lambda$, ranging from 7 to 24. The curve of the scattering area coeff. *v.* α has 3 major maxima and 2 minima in this range, with indications that the curve continues to oscillate with decreasing amplitude for increasing α. Numerous minor oscillations were found in the vicinity of the major maxima and minima. A.

535.566.2 : 538.614

2384. Magneto-optical rotatory power of hydrocarbons and their mixtures. J. TADAYON, A. H. NISSAN AND F. H. GARNER. *Analyt. Chem.*, **21**, 1532–9 (*Dec.*, 1949).

An apparatus for determination of magneto-optical rotatory power is described. The Verdet constants for Na 5 893 Å and Hg 5 461 Å, and the dispersion in the visible region are given for a number of hydrocarbons. The apparatus is used to investigate whether magnetic rotation can be used for the analysis of hydrocarbon mixtures. It is shown that in hydrocarbon mixtures magnetic rotation is an additive property when change in density on mixing is small. A method involving rotation and refractive index is proposed for analysis of ternary mixtures. A.

535.568

2385. Interference-polarization light filter for astrophysical purposes. A. B. GILVARG AND A. B. SEVERNYĬ. *J. Tech. Phys., USSR*, **19**, 997–1000 (*Sept.*, 1949) *In Russian.*

A filter is described consisting of 8 quartz plates with polaroid between them and at both ends, the direction of vibrations of the polaroid dividing in halves the angle between the vibration planes of quartz plates. The wavelengths of all transmiss bands at 36°C and normal incidence are: 7 31 6 563, 5 960, 5 470, 5 065, 4 719, 4 431, 4 186 a 3 990 Å. F. LACHM

535

2386. A comparison of direct colorimetry titanium pigments and their indirect colorimetry ba on spectrophotometry and a standard observer. D. JUDD. *J. Opt. Soc. Amer.*, **39**, 945–50 (*Nov.*, 1949

535

2387. Large fields in colorimetry. N. V. LOBANO AND G. N. RAUTIAN. *Dokl. Akad. Nauk., SSSR*, (*No.* 6) 1025–8 (1949) *In Russian.*

535.681 : 62

2388. Colour and lighting. G. T. WINCH. *G.E.C.* **16**, 197–203 (*Oct.*, 1949).

Describes, with demonstrations, the dependence subjective colour impressions on such conditions pre-adaptation of the eye, colour of surrounds, e The objective aspects of colour and colorimetry a then discussed and final sections of the paper d with the correlation of subjective impressions a objective measurements and with colour preferenc J. W. T. WALSH

53

2389. A modified Schlieren apparatus for lar areas of field. R. A. BURTON. *J. Opt. Soc. Ame* **39**, 907–8 (*Nov.*, 1949).

The limitations of conventional Schlieren syste are discussed briefly. A system replacing the poi source of light with a grid of pinholes, and the kni edge with a negative image of the grid is present as a means of overcoming these limitations. simple apparatus using this system is described, a methods of preparing and adjusting the grids a discussed. A photograph of air jets is present as experimental evidence of the sensitivity of t apparatus. It is concluded that the apparatus adaptable to large areas of field as the field is n dependent on lens size as with conventional syste instead, it is determined only by the size of the easi prepared grid. Added advantages of this syste are that a point source of light is not required, an as a result of a depth of field effect, undesirab striations along the optical path do not interfere wi the images being studied.

535.8

2390. Variable colour-amplitude phase-contra microscopy. H. BARER. Letter in *Nature*, *Lon* **164**, 1087–8 (*Dec.* 24, 1949).

Reports the use of an experimental microsco with phase retardation variable in the range $\pm\lambda$ By using a dichroic filter, what is essentially Rhei berger differential colour illumination is supe imposed on the phase-contrast effect. G. F. LOTHIA

535.822 : 535.4

2391. The interference microscope; a measuri instrument with many uses. A. KOHAUT. *Z. ange Phys.*, **1**, 165–73 (*Sept.*, 1948) *In German.*

A brief survey of the principle of the Linnik int ference microscope. Applications to metallurgic problems are described using magnifications of ×18

istrations are given of surface topographies of el balls and cylinders subjected to wear. Interence fringes for the internal bore of a 4 cm wide e are shown. Studies are made on small displaceents and estimations of refractive index of a liquid.
S. TOLANSKY

535.89

92. Spectral characteristics of light sources for ling and degradation testing. B. S. COOPER AND S. HAWKINS. *J. Soc. Dy. Col., Bradford*, **65**, 6–96 (*Dec.*, 1949).

The spectral distribution of energy in the visible d ultra-violet regions has been measured for the closed carbon arc commonly employed in fading st apparatus. Tests have been made on both d.c. d a.c. arcs, and the effect of electrical loading, ymmetrical polar distribution, and obscuration of e enclosing globe has been investigated. Certain ta are also presented for the high-intensity carbon c and for 3 types of metal-vapour electric discharge mp likely to be suitable for photochemical work. omparison is made with incandescent tungsten urces and with sunlight for corresponding spectral gions. A.

HEAT 536

536.2

393. Heating of a cylinder by solar radiation. I. BOYARINTSEV. *Izv. Akad. Nauk, SSSR, Otdel. ekh. Nauk* (*No.* 10) 1469–80 (1949) *In Russian.*

Theoretical. 3 types of cylinder are considered: a ylinder of finite length with hemispherical ends, ing on the ground; a vertical cylinder with a hemipherical top and a flat base standing on the ground; nd an infinitely long cylinder lying on the ground a pipe-line). In addition to direct solar radiation, he effects of ground reflection and atmospheric cattering are taken into account. It is shown that hen the sun is high the ratio of direct to reflected adiation is approx. $1{\cdot}22/r$ for a pipe-line running in he direction of the sun along ground of reflectivity r. bout 90% of the reflected radiation comes from a trip of ground $3\pi D$ wide where D is the pipe dia. he diurnal temp. variation of the contents of the ylinder is calculated, the results being applied to the ase of a gas-holder and a petrol-tank of 50 m³ apacity in calm spring weather in latitude 54° 20′ *N.* max. temp. rise of 15–20°C, with a daily variation f 4–5°C is estimated. A. SCHOFIELD

536.21 : 537.312.62

394. Heat transport in superconductors. K. MENDELSSOHN AND J. L. OLSEN. *Proc. Phys. Soc. ond. A*, **63**, 2–13 (*Jan.*, 1950).

The heat conduction processes in superconductors ave been discussed on the basis of the analogy with quid He II. It is suggested that under certain conitions the superconductive metal can exhibit a type f heat transport corresponding to the heat flow ssociated with the fountain effect. The heat conuctivity of a number of pure metals and alloys as been measured in the normal and in the superonductive state and the results have been analysed ith reference to the hypothesis mentioned above. In addition to the change of heat conduction with temp., the magnetic hysteresis of the heat conduction has been investigated. The use of these phenomena as make-and-break thermal contacts at very low temps. has been suggested. A.

536.222

2395. Measurements of the thermal conductivity of glycols. W. KRAUS. *Z. angew. Phys.*, **1**, 173–9 (*Sept.*, 1948) *In German.*

A description is given of measurements of the thermal conductivity, λ, of ethylene glycol and 1·2 propyl-glycol in the ranges 20–140°C and 32·5–67°C, respectively. The parallel plate method, with plate separations of 0·04, 0·11 and 0·15 cm and temp. differences of 1–2°C, was used. The apparatus is described in detail. Thermal losses were kept small by suitable guard-ring heaters. For both glycols λ decreases anomalously between 35–55°C by about 13%. The results were reproducible. The results for ethylene glycol, which is hygroscopic, were corrected for water content, the amount of which was determined by measurements of the refractive index using an Abbe refractoometer. Tests of the apparatus on water gave results in agreement with other investigators indicating that the anomalous decrease in λ for glycols was not caused by the apparatus. S. WEINTROUB

536.222

2396. Investigation of the thermal conductivity of some organic compounds in the critical region. A. K. ABAS-ZADE. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 4) 665–8 (1949) *In Russian.*

Values of thermal conductivity of benzene, toluene and xylene have been determined at high temps. and pressures. The method of "heated wire" has been used. Thermal conductivity of unsaturated vapours is < that of saturated vapours. Conductivity of these substances in liquid state slightly increases with pressure. In all cases the curves of thermal conductivity are closed along the saturation line. At pressures $> P_c$ the conductivity falls with the increase of temp. down to the critical region. At temps. $> T_c$ the conductivity rises again. F. LACHMAN

536.23

2397. Effect of temperature upon the thermal conductivity of gases. D. W. STOPS. Letter in *Nature, Lond.*, **164**, 966–7 (*Dec.* 3, 1949).

Results of measurements of the thermal conductivities of air, N and CO_2 over the range 0–1 000°C using a Pt hot-wire in a transparent fused silica tube, and a Pt resistance thermometer wound on the tube wall to determine the temps., are reported. The variation of conductivity (k) with temp. θ is expressed empirically as $k = k_0(1 + a\theta + b\theta^2 + c\theta^3)$. A table of values of the constants for the several gases is given and k/k_0 for air and CO_2 is shown graphically over range 0–1 000°C. The agreement with results of other investigators is discussed. S. WEINTROUB

536.23

2398. Thermal conductivities of organic vapours. J. D. LAMBERT, E. N. STAINES AND S. D. WOODS. *Proc. Roy. Soc. A*, **200**, 262–71 (*Jan.* 6, 1950).

The variation of thermal conductivity with pressure has been investigated for a number of organic vapours

at pressures between 50 and 700 mm and at temps. of 25, 66 and 85°C. Acetaldehyde and acetonitrile show fairly large linear increases of thermal conductivity with rise in pressure, which diminish markedly as temp. rises. This is interpreted as being due to dimerization, and a quantitative treatment is given in terms of values of K_p and ΔH for the reversible dimerization process, which are derived from previous work on the second virial coeffs. of these vapours. Ethyl chloride shows similar behaviour to a much smaller degree. Methyl alcohol and acetone show fairly large non-linear increases, which diminish at higher temps., and which are interpreted as being due to association to polymers higher than the dimer. Benzene, cyclohexane, *n*-hexane, chloroform and diethyl ether, together with air and CO_2, all show comparatively small linear increases, which become larger as temp. rises. No satisfactory quantitative explanation was found for this effect, which appears to involve factors other than simple convection. Values of the absolute thermal conductivity, corrected to zero pressure, are given for all vapours investigated. A.

536.27 : 621.318.35

2399. Steady-state internal temperature rise in magnet coil windings. C. L. EMMERICH. *J. Appl. Phys.*, **21**, 75–81 (*Feb.*, 1950).

The temperature distribution in an electric coil winding is determined by solving the differential equations which apply to the system approximately. The maximum and average temperature rises are given for several types of windings. A distinction is made between small and large temperature rise; the treatment of the former neglects local changes in resistivity and thermal conductivity caused by the increase in temperature. A correction factor is computed to obtain the actual temperature rise from the much simpler calculations for the maximum temperature rise which would occur if the resistance were independent of temperature. It is found that non-uniform windings, wound of several different wire sizes to minimize the resistance, exhibit the same temperature rise characteristics as conventional uniform windings of zero curvature. A.

536.4.031

2400. Influence of small additions of potassium on the nucleation in super-cooled mercury. V. I. DANILOV AND D. S. KAMENETSKAYA. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 4) 677–80 (1949) *In Russian.*

K was chosen as an addition, because it was known to reduce considerably the surface tension at the boundary between the liquid and vapour phase of Hg and a similar effect was expected for the separation between crystal and liquid. At a temp. reduction rate of 2·5 deg/min crystallization phenomena were observed in a wide temp. interval for some Hg specimens, for others, however, only in a narrow temp. range. The width of the temp. intervals varies with K-concentration from 2° (0·05% K) to 5° (1% K); for pure Hg it is 3°. Cases of crystallization at less intense super-cooling are due to the influences of activating additions. With rising K-concentration the depth of the supercooling is reduced, as well as the supercooling interval width; above 0·5% K the latter rises again, as does depth of supercooli The theory of the experiments enables the surfa tension at the liquid-solid separation to be det mined as 7·7 erg/cm²; this is considerably reduced admixtures up to 0·05 at.% K, but further co centration increases produce no further chan K increases activation energy. B. F. KRA

536.4

2401. Measurement of the surface temperature evaporating water drops. J. C. JOHNSON. *J. Ap Phys.*, **21**, 22–3 (*Jan.*, 1950).

Measurements are in agreement with the requi ments of the theory (Fuchs) that the temperature determined by the difference between the ambient a saturated vapour density of the drop.

536.423.1 : 532.61

2402. Effect of surface tension on heat transfer boiling. A. I. MORGAN, L. A. BROMLEY AND C. WILKE. *Industr. Engng Chem.*, **41**, 2767–9 (*De* 1949).

Heat transfer coeffs. were observed to increa qualitatively with decrease in surface tension of t liquid for temp. differences below the critical valu This is in agreement with other investigations. T critical temp. difference occurs at lower values of t temp. difference as the surface tension is lowere For solutions of wetting agents in which surfa tension is a function of time it is shown that t surface tension of a "young" surface controls the he transfer coeffs.

536.

2403. Correlation of critical temperature, boili point, and critical pressure. L. H. THOMAS. *J. Che Soc.*, 3411–15 (*Dec.*, 1949).

A reliable method of evaluating critical temps. a pressures from b.p. data is presented. By means additive functions, the b.p. of a given liquid at a giv pressure > atmospheric may be estimated wi satisfactory accuracy from the b.p. under atmospher pressure.

536.

2404. Correlation of critical temperature, vapo pressure, and latent heat of vaporisation. L. THOMAS. *J. Chem. Soc.*, 3415–19 (*Dec.*, 1949).

It is shown that the ratio of the latent heats vaporization of any 2 liquids at the same reduc temp. is a constant, and an empirical equation presented for latent heat as a function of temp. T leads to an accurate vapour pressure-temp. equati and to a method of plotting vapour pressur Methods are also given whereby the latent heat of given substance at any temp. up to the critical m be reliably estimated from vapour-pressure da extending only to the boiling point.

536.

2405. On the theory of the propagation of co bustion, with an application to the combustion of ozo C. BECHERT. *Portugal. Phys.*, **3** (*No.* 1) 29–90 (194 *In French.*

The 1-dimensional propagation of a purely therm flame is examined; the chemical reaction in the fla is bimolecular and in most of the work it is assum that the 2 reacting molecules are identical. Diffusi

oes not explicitly enter into the fundamental equations, since it may be allowed for by a suitable choice of the activation energy E. This is deduced by fitting one observed flame-speed, the same value of E then being used to calculate flame-speeds under other conditions. From the usual conservation equations, a differential equation in v and y is obtained. The dependent variable v is of the form $(E/kT_0)f/(1+x)$ where k is Boltzmann's const., T_0 the initial temp., f the fraction of unreacted molecules, and x is a complicated parameter depending on the fraction of liberated energy needed to heat the gas to the local temp. T and the fraction used to preheat the unburnt gas: the independent variable $y = E/kT - E/kT_1$ where T_1 is the temp. of the completely reacted gases. Since at $T = T_1$, $f = 0$ the required solution must pass through $v = 0$, $y = 0$. A family of such solns. exists, each one corresponding to a different value of the flame velocity U. The actual flame velocity is defined by the condition that the soln. must also pass through a particular point (v_0, y_0) determined by the state of the unburnt gas. An approx. explicit soln. for U is obtained by fitting the v–y family of curves by an algebraic expression having the correct asymptotic behaviour, which contains U as a parameter. The formula for U thus obtained resembles that of Nusselt; the dependence of U upon density, specific heat, thermal conductivity and collision frequency is the same, but the effect of initial gas temp. is somewhat different. A comparison is made between theoretical and observed flame-speeds in O_3–O_2 mixtures, choosing E to fit one observed point exactly. The error is at most 130% when the initial gas temp. varies by 180°C, and the molecular compn. varies between 75% O_2 : 25% O_3 and 50% O_2 : 50% O_3.

A. SCHOFIELD

536.46

2406. Theory of the combustion of unmixed gases. YA. B. ZELDOVICH. *J. Tech. Phys., USSR*, **19**, 1199–210 (*Oct.*, 1949) *In Russian.*

536.46

2407. Effect of pressure on burning velocity. F. H. GARNER, G. K. ASHFORTH AND R. LONG; C. TANFORD. Letters in *Nature, Lond.*, **164**, 884–5 (*Nov.* 19, 1949).

Discrepancies between results of various authors are pointed out. Measurements for benzene-air from 700–400 mm agree with the inverse fourth root law of Tanford and Pease. Tanford says this law involves simplifying assumptions and may not be obeyed strictly, as shown by calculations for butadiene-air flames. The effect of burner diameter requires elucidating; the burner walls are not likely to cause an increase in burning velocity.

A. G. GAYDON

536.46

2408. Determination of burning velocities in benzene/air mixtures. F. H. GARNER, R. LONG AND G. K. ASHFORTH. *Fuel*, **28**, 272–6 (*Dec.*, 1949).

Anomalous results have been obtained by the shadow photograph method and the consideration of these has led to the adoption of a new procedure for evaluating the burning velocities from the shadow and direct photographs of the flame.

A.

536.46

2409. The effect of pressure on the burning velocity of ethylene-air mixtures. P. J. WHEATLEY AND J. W. LINNETT. *Trans. Faraday Soc.*, **45**, 1152–8 (*Dec.*, 1949).

Using the burner method it is found that the burning velocity for a given mixture increases as the pressure is reduced below atmospheric. In the range from ½ to 1 atm. the burning velocity is approx. inversely $\propto$ the fourth root of the pressure. This is in agreement with the prediction of Tanford and Pease. The results do not agree with the predictions of Gaydon and Wolfhard [Abstr. 1870 (1949)] or with the behaviour suggested by the formula of Boys and Corner [Abstr. 4212 (1949)].

A.

536.46

2410. The inflammation of alkyl nitrate vapours and the effect of inert diluents. P. GRAY AND A. D. YOFFE. *Proc. Roy. Soc. A*, **200**, 114–24 (*Dec.* 22, 1949).

The investigation was made over the range 240 to 500°C. The explosion of methyl nitrate is facilitated by both A and N_2. With O_2 as diluent, explosive combustion occurs. The results show that the explosion is not thermal as has been suggested, but is due to chain branching. A glow region has been observed with methyl nitrate, ethyl nitrate and nitroglycerin, and this region lies below that of explosion on the pressure-temp. graph. These nitrates even when diluted from 10^3 to 10^6 times with inert gases glow on admission to a hot quartz vessel; O_2 and air are less efficient than N_2 or A in facilitating the glow. It is suggested that the glow is associated with the production of excited formaldehyde molecules.

A.

536.46

2411. Augmented flames in half-open tubes. M. W. EVANS, M. D. SCHEER, L. J. SCHOEN AND E. L. MILLER. *J. Appl. Phys.*, **21**, 44–8 (*Jan.*, 1950).

High velocity flames in half-open tubes produced by placing a grid augmenter in the path of an advancing flame are described. High-speed schlieren motion pictures and instantaneous pressure measurements are used to study flame structure and accompanying flow in the tube. It is found that the grid augmenter causes a mixing of burning and unburned gases, resulting in an increase in reaction surface. As a result the total amount of reaction per unit time per unit volume is increased, thus leading to the observed high velocities.

A.

536.46

2412. Combustion of liquid fuel in a gas stream. I. D. B. SPALDING. *Fuel*, **29**, 2–7 (*Jan.*, 1950).

A theory is developed for predicting the combustion rate from the physical properties of the fuel by analogy with heat transfer processes. Experiments are described which confirm the validity of the theory and throw light on the laws determining the limits of stable combustion, the occurrence of smoke and the combustion mechanism.

A.

536.46

2413. Regions of inflammability of methane. J. ELSTON AND P. LAFFITTE. *Fuel*, **29**, 8–12 (*Jan.*, 1950).

With the $CH_4 + O_2$ mixture and with the $CH_4 + (79x + 21\ O_2)$ mixture when x is N_2, A or CO_2 but not He, flames were observed of which the shape was

different from that of normal flames and which were separated from the walls by a big space. With a 25 mm tube the region of inflammability extends at low pressure towards weak concentrations of methane (lower than the lower limit at atmospheric pressure). For a 16 mm tube, they are found only in a small region beyond the generally recognized lower limit. These thin flames are due to excess of O. Finally, the action of diluents on the $CH_4 + 2O_2$ mixture at low pressures differs considerably from the action on the $2H_2 + O_2$ mixture. A.

536.46

2414. Propagation of flame. J. W. Linnett. *Fuel*, **29**, 13–15 (*Jan.*, 1950).

The importance of the measurement of flame velocities in attempting to assess the relative importance of thermal conduction and radical diffusion in the propagation of flames is pointed out. The methods that have been used by the author to determine flame velocities are briefly described. They are the burner method, and the soap bubble method. A few examples are given of the usefulness of the results in obtaining information about the mechanism of flame propagation. A.

536.46 : 534.413

2415. The effect of sound on laminar propane-air flames. S. Loshaek, R. S. Fein and H. L. Olsen. *J. Acoust. Soc. Amer.*, **21**, 605–12 (*Nov.*, 1949).

The application of sound of known intensity and a frequency of 12·7 kc/s to a laminar propane-air flame is found to produce a shift in the stability limits of the flame. The sound alters the flashback limit so that the flame becomes more stable and the blow-off limit so that the flame becomes less stable. It is shown that the normal burning velocity is not changed with the application of sound and that the flow-velocity profile in the tube is likewise unchanged. From the Lewis and von Elbe theory of flame stabilization it is then concluded that the "penetration distance" must be increased. The "penetration distances" are calculated from the flow-velocity distribution and the normal burning velocity and, near stoichiometric, are found to increase about 20% at the maximum sound intensity of 10 milliwatts/cm². Sound at a frequency of 18·3 kc/s is found to affect the blow-off limit in a manner similar to the lower frequency but no appreciable effect is noted on the flashback limit. It is concluded that these results in combination with further experimental studies should yield useful information about the nature of the "penetration distance" and flame holding in general, but that sound at these low frequencies does not offer a useful tool for studying flame propagation. It is recommended that the effects of sound on practical burners be given careful study because the results presented indicate that the maximum quantity of energy that can be released in a given burner volume may be limited by the sound level in the combustion chamber. A.

536.48

2416. The present state of the He II problem. L. Meyer and W. Band. *Naturwissenschaften*, **36** (*No.* 1) 5–16 (1949) *In German.*

A general review with particular stress on recent theory. H. LONDON

536.4

2417. The thermodynamics of liquid helium on the basis of the two-fluid theory. O. K. Rice. *Phys. Rev.*, **76**, 1701–7 (*Dec.* 1, 1949).

It is pointed out that there is some evidence that the phases are separated not only in momentum space as in London's theory based on the Bose–Einstein gas, but also in ordinary space. The specific heat just above the λ-point is considered on the assumption that in this region superfluid is beginning to appear in the form of small globules of 60 to 80 He atoms. The thermodynamic properties below the λ-point are used to estimate the entropy of mixing of the two fluids in this region. The results suggest that in this region the superfluid forms a "partially condensed system," having possibly a fibroid structure. The nature of the 2nd-order transition at the λ-point is considered in the light of this picture. A new relation is derived for the change of the λ-point with pressure, and the change with concentration of He^3 is also considered. A.

536.48 : 533.24

A small helium liquifier and portable cryostat. *See Abstr.* 2241

536.48 : 539.152.2

Attempts to detect alignment of atomic nuclei. *See Abstr.* 2630

536.52 : 537.523.5

2418. On a new method of temperature measurement in high temperature arc columns. H. Bartels and W. Göing. *Naturwissenschaften*, **36** (*No.* 9) 279 (1949) *In German.*

If, in the line-reversal method, in addition to the resonance lines, lines of higher order in the ground state are present, then from the intensities of such lines flanking the central reversed minimum the temp. of the arc can be determined. The theory of the method is briefly given. S. WEINTROUB

536.521

2419. An optical pyrometer employing an image-converter tube for use over the temperature range 350–700°C. C. R. Barber and E. C. Pyatt. *J. Sci. Instrum.*, **27**, 4–16 (*Jan.*, 1950).

An i.r. image-convertor tube is associated with a form of disappearing-filament optical pyrometer to enable readings to be taken at temps. as low as 350°C. By use of a strip of paper illuminated by a lamp, instead of the normal pyrometer lamp filament, a reproducibility of 1–2°C has been secured in the range from 350 to 700°C. The observer's eyes must be dark-adapted in varying degree according to the temp. to be measured. At the lowest temp. about 15–20 min must elapse after the observer enters the darkened room, from daylight, before he can make accurate readings. A rough calculation of the effective wavelength of the pyrometer gives a value of 1 μ and the effect of variations in this value is discussed. A.

536.521

2420. Pyrometer for measurement of instantaneous temperatures of flames. J. H. Hett and J. B. Gilstein. *J. Opt. Soc. Amer.*, **39**, 909–11 (*Nov.*, 1949).

Dual paths, which are nearly coincident, are used with two photo-multipliers and a single filter to obtain on c.r.t.'s records of the radiation from rapidly varying

mes. Both temp. and emissivity are determined. libration is by standardized strip lamp. Successful cords of the temp. in the combustion chamber of a ge pulse jet have been made. The error at 2 000°K of the order of ± 20°K. A.

536.53

21. A simple device for recording mean temratures in confined spaces. A. MACRADYEN. Letter *Nature, Lond.*, **164**, 965–6 (*Dec.* 3, 1949).

The device, suitable for ecological studies and which ves satisfactory results in the field, consists of a V accumulator, Type F thermistor (*a*) and resisnce *R* in series, with a similar thermistor (*b*) and Ag ltameter in series shunted across *R*. Mean temp. calculated from the gain in weight of the voltameter thode. The value of *R* is determined empirically sing water-baths at constant temps. By suitable oice of *R* the relation between current through the ermistor (*b*) and temp. can be made to conform to e same law as that which governs metabolic-rate. he particular pattern of Ag voltameter used is lustrated. S. WEINTROUB

536.531

422. A device for the measurement of rotor temerature in the air-driven ultracentrifuge. P. G. CKER, J. BLUM AND C. W. HIATT. *Rev. Sci. Instrum.*, **0**, 799–801 (*Nov.*, 1949).

A device is described which permits the measureent of rotor temp. in the air-driven ultracentrifuge hile the machine is in operation at speeds up to 0 000 r.p.m. A thermistor situated inside the rotor hanges its resistance as the temp. changes. Measureent of the thermistor resistance by means of a Wheatstone bridge is accomplished with the use of eedle contacts on the top of the turbine shaft and at he bottom of the rotor. Rotor temp. may be neasured to within ± 0·02°C and is believed to epresent actual temp. of the rotating solution within 0·1°C. A.

536.531

2423. Application of thermistors to cryoscopy. B. M. ZEFFERT AND S. HORMATS. *Analyt. Chem.*, **21**, 1420–2 (*Nov.* 14, 1949).

The advantages are briefly discussed. A simple ryostat suitable for determinations in the range room emp. to −60°C, the temp. element of which is a Western Electric Type 14B thermistor connected to a Wheatstone bridge circuit, is described in detail. The element was calibrated at the freezing points of H_2O, CCl_4, bromobenzene, Hg, chlorobenzene and chloroform, and points above 0°C were obtained by constant-temp. water baths regulated to ± 0·02°C. Curves of the variation of the log. of resistance with he inverse absolute temp. of the thermistor, and of the freezing of H_2O and Hg are shown.

S. WEINTROUB

536.531

2424. Portable precision resistance thermometer equipment for mains operation. J. A. HALL. *J. Sci. Instrum. Phys. Ind.*, **26**, 392–6 (*Dec.*, 1949).

Ni resistance thermometers have been designed for clinical use, together with a portable mains-operated resistance bridge of the Callendar–Griffiths type. An accuracy of ± 0·01°C is claimed. A.

536.531 : 537.3

2425. An absolute noise thermometer for high temperatures and high pressures. J. B. GARRISON AND A. W. LAWSON. *Rev. Sci. Instrum.*, **20**, 785–94 (*Nov.*, 1949).

A null device for determining the ratio of two absolute temps. with an accuracy of 0·1% is described. This device balances the mean-square fluctuations in voltage across the terminals of two resistors arising from thermal agitation at the temps. to be compared. The ratio of the resistances, when the noise voltages from the two resistors are equal, determines the ratio of their absolute temps. An observation time of 2 min is adequate. Tests have been conducted in the neighbourhood of 1 000°K. Extrapolation indicates that material improvements in the accuracy of the absolute temp. scale above 2 000°K may be obtained. A.

536.531 : 537.312.62

2426. Nickel films used as thermometers at low temperatures and superconductivity of lead films. A. VAN ITTERBEEK, L. DE GREVE, R. LAMBEIR AND R. CELIS. *Physica*, **15**, 964–70 (*Dec.*, 1949).

Measurements are made on Ni films with negative temp. coeff. used as thermometers in the temp. region of liquid H and He. These resistance thermometers have been applied to measurements on superconductivity of Pb films sputtered in N_2 gas. A.

536.532 : 536.2.08

2427. A new heat-flow meter. H. S. HATFIELD AND F. J. WILKINS. *J. Sci. Instrum.*, **27**, 1–3 (*Jan.*, 1950).

A heat-flow meter is described having the form of a small disc of Te–Ag alloy with Cu-gauze coating on its two sides. This is placed with its plane at r. angles to the flow of heat to be measured, creating a small proportionate difference of temp. between the two sides. The output of the disc is 2·0 μV for a flow of 1 B.Th.U./ft²/hr. The internal resistance including leads is 1 Ω. The disc is connected by fine wires through a terminal block some distance away to a galvanometer which registers the thermo-e.m.f. due to the difference in temp. of the two Te–Cu junctions. The disc is calibrated by placing it in a measured heat-flow through a number of layers of plush. Experiments carried out in a room-size steel-walled chamber with one or more of its walls heated gave an approximately correct figure for the heat imparted to the injected air current, the volume and change of temp. of which were measured. A.

536.532 : 537.323

2428. Thermocouples of the refractory metals. F. H. MORGAN AND W. E. DANFORTH. *J. Appl. Phys.*, **21**, 112–13 (*Feb.*, 1950).

The thermoelectric power of several refractory thermocouples was investigated, W–Ta for temperature measurements up to 3 000°C, W–Mo up to 2 600°C, Ta–Mo up to 2 600°C and W–W/Mo (alloy 50% Mo/50% W) up to 2 900°C. Basic calibration was carried out using several melting points and the results were verified and interpolated by means of an optical pyrometer. The couples W–Ta and W–Mo have been applied in this laboratory to the temperature measurement requirements in high tempera-

ture vacuum furnaces and determinations of spectral emissivity. A.

536.6 : 539.16.08

Calorimetric radioactivity measurements. *See Abstr.* 2641

536.63

2429. The low temperature heat capacity of columbium nitride. G. T. ARMSTRONG. *J. Amer. Chem. Soc.*, **71**, 3582–7 (*Nov.*, 1949).

This has been determined in the range from 11 to 21°K. An anomaly of 0·023 cal. mole^{-1} occurs at 15°K, and may be associated with the transition to superconductivity. The effect of mag. fields of 250, 500, 750 and 1 000 gausses is very small both on the magnitude of the heat capacity and the change in temp. of the anomaly. No latent heat of transition was observed. A.

536.631

2430. Heat capacities at low temperatures and entropies of magnesium and calcium fluorides. S. S. TODD. *J. Amer. Chem. Soc.*, **71**, 4115–16 (*Dec.*, 1949).

These have been measured throughout the range 52 to 298°K. The entropies at 298·16°K have been calculated to be 13·68 ± 0·07 and 16·46 ± 0·08 cal./deg./mole, respectively. A.

536.655

2431. Note concerning some recent statements on the latent heat of vaporization of carbon. L. H. LONG AND R. G. W. NORRISH. *Trans. Faraday Soc.*, **45**, 1158 (*Dec.*, 1949).

Points out the misleading nature of some recently published statements relating to an earlier paper on the thermochemistry of C. [*Proc. Roy. Soc. A*, **187**, 337 (1946)].

536.655

2432. Vapour pressure of titanium. J. M. BLOCHER AND I. E. CAMPBELL. *J. Amer. Chem. Soc.*, **71**, 4040–2 (*Dec.*, 1949).

This has been determined in the range 1 500–1 800°K by measuring the rates of evaporation of Ti wire using the Langmuir technique. The data fit the thermodynamic requirements quite well and yield heats of sublimation of 111 000 cal. at 0°K and 111 700 at 298·2°K. The resulting equation for the vapour pressure of solid β-Ti, valid over the range 1 200–2 000°K, is $\log p$ (atm.) $= 7{\cdot}782 - (24\,275/T) - 0{\cdot}230\times10^{-3}\,T$. The data may be extrapolated to yield an equation for the vapour pressure of the liquid: $\log p$ (atm.) $= 6{\cdot}255 - (22\,110/T)$, leading to a normal boiling point of 3 535°K. A.

THERMODYNAMICS 536.7/.8

536.7 : 551.5

2433. Final report of the working sub-committee of the International Joint Committee on Psychrometric Data. J. A. GOFF. *Trans. Amer. Soc. Mech. Engrs*, **71**, 903–13 (*Nov.*, 1949).

The recommendations, with full explanations, of the sub-committee regarding the thermodynamic properties of moist air which can claim acceptance as standard owing to their thermodynamical consistency within the accuracy of existing knowledge are discussed. The use of Dalton's law or its various modifications is abrogated. The statistical mechanical relation for the chemical potential $\mu_i = g_i^0(T) - RT\ln(x_i p) + p[\sum_{ik} x_i x_k A_{ik}(T) - 2\sum_k x_k A_{ik}(T)] + \ldots$ is taken as basic from which the various thermodynamical properties are to be derived. $g_i^0(T)$ is the zero-pressure reduced free enthalpy and is to be computed from the best available spectroscopic data; x_i, x_k are mol. fractions; and $A_{ik}(T) = A_{ki}(T)$ are second-virial coefficients ($i = k$) and interaction coeffs. ($i \neq k$). The mol.-fraction composition of dry air is defined as O_2 0·2095; N_2 0·7809; A 0·0093 and CO_2 0·0003. The values of the 1947 International Committee on Atomic Weights are recommended. Moist air is regarded as a binary mixture of dry air and water vapour. Tables of values, the majority at intervals of 10°C between −90 and +90°C, include the following:—the zero-pressure enthalpy and the zero-pressure reduced entropy of dry air and of water vapour; the second virial coeffs. of dry air and the second and third virial coeffs. of water vapour; the interaction coeffs. of moist air; the saturation pressure of ice and water and the saturation pressure and specific heat of the undercooled liquid; the humidity ratio, i.e. the weight of water vapour per unit weight of dry air, at saturation at standard atmospheric pressure; the volume, enthalpy, and entropy of moist air per unit weight of dry air at standard atmospheric pressure. The sources and method of derivation of these tables are given. The thermodynamic dew-point and wet-bulb temperatures are defined. A bibliography of 37 references is appended. S. WEINTROUB

536.71

2434. On the condition of equilibrium of the gas phase of a binary solution and on Van der Waals's equation. M. A. RESHETNIKOV. *Dokl. Akad. Nauk SSSR*, **68** (*No.* 3) 531–4 (1949) *In Russian.*

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.122

2435. A comparison of the *g* value of the electron in hydrogen with that in deuterium. E. B. NELSON AND J. E. NAFE. *Phys. Rev.*, **76**, 1858–60 (*Dec.* 15, 1949).

The g value of the electron in the $^2S_{\frac{1}{2}}$ state of H has been compared with the g value of the electron in the corresponding state of D by the atomic beam magnetic resonance method. The frequencies, f_H of the transition $(1, 0 \leftrightarrow 1, -1)$ in H, and f_D, of the transition $(\frac{3}{2}, -\frac{1}{2} \leftrightarrow \frac{3}{2}, -\frac{3}{2})$ in D were observed in the same magnetic field and the ratio $(g_J)_H/(g_J)_D$ was computed from the Breit–Rabi formula. The principal uncertainty is caused by the drift of the magnetic field. The average of 36 observations in 4 runs in which f_H and f_D were measured alternately is $(g_J)_H/(g_J)_D = 1{\cdot}000004 \pm 0{\cdot}000025$. The average

f 3 runs in which the two resonances were observed multaneously is $(g_J)_H/(g_J)_D = 0{\cdot}999991 \pm 0{\cdot}000010$. he uncertainty indicated in each result is the mean eviation of the residuals. It is concluded that the g alue of the electron when bound to the proton iffers from that when bound to the deuteron by $<$ 0·001%. A.

537.122 : 530.145

A note on electron theory. *See Abstr.* 2193

537.122 : 621.3.01

436. Special relativity and the electron. W. W. HARMAN. *Proc. Inst. Radio Engrs*, **37**, 1308–14 *Nov.*, 1949).

A simple account of the special relativity theory, illustrated by examples in electronic engineering.

P. M. DAVIDSON

ELECTROSTATICS . DIELECTRICS 537.2

537.221

2437. Electrification of liquid drops. E. W. B. GILL AND G. F. ALFREY. Letter in *Nature, Lond.*, **164**, 1003 (*Dec.* 10, 1949).

A jet of water falling vertically from an earthed metal reservoir was surrounded by an insulated metal cylinder which could be charged to various potentials V between $\pm$ 1 000 V. The charge Q per cm³ acquired by the water on breaking up into drops was found to be $\propto$ V. The small value of Q remaining when $V = 0$ is attributed to contact potential difference between water and reservoir. In similar experiments with insulating liquids (CCl_4, transformer oil) an applied field had no effect.

E. M. FOURNIER D'ALBE

537.226.1

2438. On the nature of ferroelectricity in Rochelle salt. M. S. KOSMAN. *J. Exp. Theor. Phys., USSR*, **19**, 899–907 (*Oct.*, 1949) *In Russian.*

It is shown that the permittivity ε of a Rochelle salt crystal cut perp. to a depends partly on surface properties. The formation of a layer of low ε between the electrode and the crystal is not thought to be adequate explanation of the variation of ε with specimen shape and electrode area. Measurements were made under various conditions of humidity.

A. L. MACKAY

537.226.1

2439. The dielectric properties of barium titanate. R. E. AVERBUKH AND M. S. KOSMAN. *J. Exp. Theor. Phys., USSR*, **19**, 965–70 (*Nov.*, 1949) *In Russian.*

By partially discharging a condenser through a ballistic galvanometer the permittivity, ε, of $BaTiO_3$ was measured under various conditions of temp. and electric field. Discharging at different rates permitted 2 components of ε to be distinguished which depend differently on temp., frequency and field. The high h.f. part of ε has a sharp peak at 120°C (as found by a.c. methods), but the total effective ε rises rapidly to a max. at about 150°C and remains almost constant up to 270°C. The ratio (ε at 5 kV/cm) to (ε at 0·5 kV/cm) decreases smoothly from 2 at 20° to 0·5 at 140°C. A. L. MACKAY

537.226.2

2440. Dielectric precision measurements on solutions of associated substances. V. Dipole moment and association of alcohols and substituted phenols. R. MECKE AND A. REUTER. *Z. Naturforsch.*, **4a**, 368–78 (*Aug.*, 1949) *In German.*

Precision measurements of permittivity have been made on various solutions of CH_3OH, C_2H_5OH, n-C_4H_9OH, n-$C_8H_{17}OH$, C_6H_5OH, p-$C_6H_4(OH)CH_3$, o-$C_6H_4(OH)CH_3$, o-$C_6H_4(OH)Cl$, o-$C_6H_4(OH)COCH_3$, $C_6H_4(OH)OCH_3$, $C_6H_4(OH)CHO$, $C_6H_4(OH)CO_2CH_3$, o-$C_6H_4(OH)NO_2$, $C_6H_5NO_2$, and C_6H_5CHO in C_6H_6, CCl_4, and *cyclo*hexane at 20° and 40°. Dipole moments have been derived by a modified Onsager expression and molecular association has been computed. For alcohols and phenols the dipole moment is reduced by association and the binding moment of OH-group is usually not much more than half the value for the free unassociated molecule. Temp. and solvent influences and concentration effects are discussed in relation to inter- and intra-molecular H bonding. W. R. ANGUS

537.226.2

2441. Anomalies in the dielectric properties of uranium dioxide. J. DAY, M. FREYMANN AND R. FREYMANN. *C.R. Acad. Sci., Paris*, **229**, 1013–14 (*Nov.* 15, 1949) *In French.*

The dielectric constant (ε') and power loss factor (ε'') are determined for UO_2 in the form of a fine powder from 2 kc/s to 1 Mc/s at temps. between $-$ 160° and $+$ 20°C. There are signs of a peak in the ε'' *v.* temp. curve at about $-$ 150°C due to dipole orientation. E. RUSHTON

537.226.2

2442. On the ferroelectricity of KH_2PO_4 and KD_2PO_4 crystals. J. PIRENNE. *Physica*, **15**, 1019–22 (*Dec.*, 1949).

The ferro-electric properties of KH_2PO_4 and KD_2PO_4 crystals exhibit a most striking, yet unexplained, isotopic effect: the Curie point, for instance, is shifted by as much as 90° and other physical properties are surprisingly different in both crystals. The analysis of this situation leads to a new theory in which the protons are moving in a certain potential well, the spontaneous polarization arising from the electrostatic dipole-dipole interaction; the isotopic effect has a simple quantum-mechanical origin. The case of a square well potential is studied in detail as offering a suitable discussion base. It already leads, in the inner-field approximation, to a quantitative agreement for the Curie point, saturation polarization, paraelectric Curie constant and total extra heat of both crystals. The width of the well is found to correspond to a separation of about 148 cm^{-1} between the two first proton levels. The values which have to be assigned to the Lorentz factor and to the ionic character of the protons are quite reasonable and the contribution of the ground to the polarization appears to be of the same order of magnitude as that of the protons. Further experiments, and especially for i.r. absorption spectra, seem to be extremely desirable in order to improve the model. A.

537.226.2 : 548.0

Dielectric constants and polarizabilities of ions in simple crystals and barium titanate. *See Abstr.* 2761

537.226.3 : 541.64

2443. Cohesion and polymerization of large molecules according to their dielectric loss. P. GIRARD, P. ABADIE AND R. CHARBONNIÈRE. *C.R. Acad. Sci., Paris*, **229**, 1316–19 (*Dec.* 14, 1949) *In French.*

Results for 4 polyvinyl chlorides of different mol. wts. are reported. For temps. $T < 70°C$ curves of dielectric loss differ from Debye's, representing the solid state; they show no relaxation characteristics or viscosity. For $T = 80$–$100°C$ curves of Debye type with viscosity arise, representing the liquid state. Between 70–80°C the states coexist, their relative importance depends on the degree of polymerization of the whole molecule. As mol. wt. goes from 70 000 to 23 000 the relative importance of the liquid state grows and molecular cohesion decreases. J. JACOBS

537.226.3 : 621.315.615.9 : 621.317.37

2444. Measurements of the temperature-dependence of the permittivity and the loss angle of dielectrics in the cm-wave range. D. MASH, L. MAYANTS AND I. FABELINSKIĬ. *J. Tech. Phys., USSR*, **19**, 1192–8 (*Oct.*, 1949) *In Russian.*

The method used was that of Roberts and Hippel [*J. Appl. Phys.*, **17**, 610 (*July*, 1946)], but its theoretical evaluation was found unwieldy, inaccurate and not generally applicable. The authors developed a method of evaluation free from these drawbacks. Its application is shown by measurements of the permittivity and loss angle of glycerine at the 3·22 cm wavelength, at which the temp.-dependence was also determined. B. F. KRAUS

537.228.1

2445. Phase transition and the piezoelectric effect of KH_2PO_4. S. YOMOSA AND T. NAGAMIYA. *Progr. Theor. Phys.*, **4**, 263–74 (*July–Sept.*, 1949).

Slater's theory is extended to the case of a strained crystal, formulae being given for the transition temp. and the dielectric, piezoelectric and elastic constants. The calculated values of these constants are in close agreement with those observed by Mason.

H. J. H. STARKS

537.241

2446. A method for studying the distribution and sign of static charges on solid materials. H. H. HULL. *J. Appl. Phys.*, **20**, 1157–9 (*Dec.*, 1949).

A special powder is used to show how static electricity is distributed on materials such as paper. Red particles of this powder are attracted to positively charged areas and blue particles are attracted to negatively charged areas. Paper from heat-set printing presses shows streaks of static electricity generated by idling rollers and shifting patterns of static electricity generated in the folder, often with opposite charges on the same sheet of paper. A.

537.29

2447. Induced fibration of suspensions. W. M. WINSLOW. *J. Appl. Phys.*, **20**, 1137–40 (*Dec.*, 1949).

Describes some of the phenomena found to have their origin in electrically induced fibration of small particles in fluid liquid suspension. Particular attention is given to induced shear resistances found in layers of the fluid (0·01 to 0·15 cm) when bounded by potentialized electrode surfaces. Ingredients and manner of compounding concentrated fluids capable of reversible shear resistance up to several 100 g/cm² are described. Dynamic induced shear resistance or the corresponding induced bulk viscosity are shown to be a parabolic function of field strength wherein parameters dependent on surface conditions of the particles are involved. Various properties of these fluids are discussed with regard to the mechanism of induced fibration, its application in slip clutches and other hydraulic devices, and some of the factors for best results. Consideration is given to the analogous magnetically induced fibration of ferromagnetic particles in fluid suspension. It is found that the observed values of induced shear resistance approximate those predictable from the well-known formulae for tractive force in both the electric and magnetic cases. Mention is also made of fluid suspensions of ferrite powders which respond to both electric and magnetic fields. A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 536.531

An absolute noise thermometer for high temperatures and high pressures. *See Abstr.* 2425

537.311.3 : 535.231.4

2448. The physical properties of titanium. I. Emissivity and resistivity of the commercial metal. W. C. MICHELS AND S. WILFORD. *J. Appl. Phys.*, **20**, 1223–6 (*Dec.*, 1949).

These have been measured from room temp. to 1 400°K. The resistivity at 20°C is 78·6 microhm cm. Above this temp. it increases to a flat max. of 182 microhm cm at the temp. of the hexagonal-body-centred cubic transformation. The total emissivity is about 0·31 at low temps. and there is some indication that it shows a max. near the transition temp. The spectral emissivity and the brightness temp. scale are also determined over the range of 1 000°K–1 400°K. A.

537.311.3 : 539.21

The Herzfeld metal criterion and the problem of the existence of a non-conducting amorphous modification of all metals. *See Abstr.* 2701

537.311.33

2449. Electron conduction in non-metals. G. BUSCH. *Z. angew. Math. Phys.*, **1** (*No.* 1) 3–31 (1950) *In German.*

A summarizing review of semiconductor properties and the relevant theoretical interpretations. The concentration of free charge carriers is deduced for intrinsic and impurity semiconductors, and corrections are given which must be applied when the electron gas is degenerate. The mean free path of charge carriers is limited by thermal vibrations of the lattice and by impurity scattering. Its temp.-dependence in ionic and non-polar crystals is discussed. Measurements of the Hall effect can be used to determine experimentally the concentration of

carriers, their sign and their mobility. An allied phenomenon is the variation of resistivity with magnetic field. This effect should reach saturation for very strong fields. The disturbing effect of heterogeneities in the form of grain structure or non-uniform distribution of impurity centres is emphasized. The case of ZnO, an excess semiconductor, is treated in some detail. H. K. HENISCH

537.311.33

2450. On the abnormal electrical properties of vanadium trioxide between − 100°C. and + 300°C. M. FOËX. *C.R. Acad. Sci., Paris*, **229**, 880–2 (*Nov.* 2, 1949) *In French.*

Between − 25° and + 235°C the behaviour is unusual in that the resistance increases with increasing temps. Below − 25° and above + 235°C the resistance decreases with increasing temp. The coeff. of expansion is measured between − 200° and + 1 000°C, and shows an increase with increasing temp. from − 100° to + 1 000°C, the most rapid increase being between − 100° and + 200°C.

E. RUSHTON

537.311.33

2451. Background noise in semiconductors. I. H. F. MATARÉ. *J. Phys. Radium*, **10**, 364–72 (*Dec.*, 1949) *In French.*

Starting with a semi-empirical relation for the static voltage/current characteristic of a crystal diode, a value for the r.m.s. noise voltage across a barrier may be calculated by means of an equivalent circuit for the semiconductor rectifier using noise generators. The question of equivalent noise temp. of the semiconductor is solved by comparison between the noise temp. of a hot cathode and that of the barrier layer considered. A general relation is obtained which determines the statistical fluctuations of current in crystal diodes and which agrees well with measured values at low applied fields (0 to 0·3 V).

C. A. HOGARTH

537.311.33

2452. Properties of single crystal selenium prepared from a melt. H. W. HENKELS. Letter in *Phys. Rev.*, **76**, 1737–8 (*Dec.* 1, 1949).

Single crystals of Se were grown in a glass vessel heated in a bath of boiling methyl salicylate (223°C). An inner vessel was kept at the temp. of boiling naphthalene (218°C). Electrostatic probe measurements of resistivity were carried out in vacuum and the anisotropic properties of Se investigated. The resistivity was found to change with time during the application of electric fields. Activation energies of about 0·25 eV were determined. H. K. HENISCH

537.311.33

2453. Image force in rectifiers. P. T. LANDSBERG. Letter in *Nature, Lond.*, **164**, 967–8 (*Dec.* 3, 1949).

The diffusion theory of barrier layer rectification leads to an expression for the current corresponding to a given applied voltage which depends on the manner in which the potential varies as a function of distance from the metal electrode. This expression is simply evaluated if image forces are neglected. When allowance is made for the effect of image forces, the expression can be calculated by means of Laplace's approximation. This leads to a result which is very suitable for comparison with experimental measurements. The agreement is shown to be satisfactory for a Cu oxide rectifier. H. K. HENISCH

537.311.33

2454. Electrical properties of products of the system titanium oxide-aluminium oxide reduced by hydrogen. R. CAUVILLE. *C.R. Acad. Sci., Paris*, **229**, 1228–30 (*Dec.* 5, 1949) *In French.*

The mixture of Ti and Al oxides, in the form of small cylinders, was reduced by pure H, and the product tempered in an atmosphere of H. The resistivity of the products was determined. Curves showing the variation of resistivity with the composition of the original mixture and for different degrees of reduction are given. The max. resistivity occurs when the original mixture contains equimolecular amounts of the two oxides. The temp. coeff. of resistivity is practically independent of the extent of reduction. It is probable that the composition TiO_2, Al_2O_3 represents either a definite compound or a very stable structure which is not affected by the loss of O ions. This is confirmed by X-ray analysis. The products may be of practical value as resistances which vary rapidly with temp.

A. J. MEE

537.311.33

2455. The electric conductivity of simple semiconductors. W. EHRENBERG. Letter in *Proc. Phys. Soc. Lond. A*, **63**, 75–6 (*Jan.*, 1950).

On the basis of work by Shifrin [Abstr. 629 (1947)], an analytic expression valid at all temps. is given for the conductivity of a semiconductor whose conductivity is due to electrons from a single kind of impurity centre. D. SHOENBERG

537.311.33 : 535.345

The reflectivity of germanium semiconductors. *See Abstr.* 2351

537.311.33 : 538.69 : 621.314.631 : 621.315.59

2456. Magnetically biased transistors. C. B. BROWN. Letter in *Phys. Rev.*, **76**, 1736 (*Dec.* 1, 1949).

According to present theories of transistor action, the h.f. response is limited by the transit time of positive holes from the emitter to the collector. This time depends on the path length. If a magnetic field of suitable polarity is applied in a direction perp. to the current, the positive hole flow can be restricted to the surface region and the transit time therefore decreases. Magnetic fields of opposite polarity increase the path length and thus increase the transit time. It is shown that, accordingly, type *A* transistors which are magnetically biased can be used for amplification purposes at considerably higher frequencies than has been possible hitherto.

H. K. HENISCH

537.311.33 : 621.314.63 : 621.315.59

2457. Dependence on frequency of the uni-polar conductivity of contacts. I. G. NEKRASHEVICH AND T. Z. FISHER. *J. Tech. Phys., USSR*, **19**, 1312–20 (*Nov.*, 1949) *In Russian.*

Investigation of a crystal rectifier (PbS) in a wide frequency interval. Curves of rectified current *v.* amplitude of applied voltage and frequency were obtained for electronic and of "hole" conductivity. Inversion of the rectification effect occurs at definite

relations between frequency and amplitude of the applied voltage. An equivalent valve circuit is presented demonstrating the behaviour of the detector considered. B. F. KRAUS

537.311.4

2458. Thermal potentials in platinum contacts. I. DIETRICH AND E. RÜCHARDT. *Z. Naturforsch.*, **4a**, 482–6 (*Oct.*, 1949) *In German.*

It is shown experimentally that the thermal potential observed when crossed Pt wires are unsymmetrically heated is due to a thin film of impurity between them. The thermal potential, and the thermal resistance of the unimolecular impurity film, were determined. The measurements were in good agreement with values calculated from the theory of Kohler [*Ann. Phys.*, **38**, 542 (1940) and *Naturwissenschaften*, **29**, 164 (1941)]. P. M. DAVIDSON

537.312.5

2459. Influence of the temperature on the external photo-effect for semi-conductors. A. N. ARSENEVA-GEĬL. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 2) 245–7 (1949) *In Russian.*

A temp. rise in a semiconductor alters the distribution of the electrons over the energy states. This fact should cause a corresponding variation in the initial energy distribution of the electrons liberated by light. The investigation showed that the influence of a temp. rise acts quite differently on semiconductors and on metals. For semiconductors even an insignificant temp. rise (by some 10ths of degrees) produces a considerable variation of the energy distribution of the liberated electrons. This variation is greatest in the range of high energies where a marked increase in the number of photo-electrons is observed, some of which shows velocities $\gg$ the maximum speed of photo-electrons at room temp.

B. F. KRAUS

537.312.5

2460. Complex investigation of the photoconductivity of cuprous oxide. S. M. RYVKIN. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 3) 487–90 (1949) *In Russian.*

The stationary value of photoconductivity attained after a sufficiently prolonged illumination can be represented as the product of: (1) e (charge on an electron); (2) u and (3) τ (mobility and life of the carriers of the photocurrent, respectively); (4) k (absorption coeff.) or L (coeff. depending upon the dimensions of the sample); (5) I (intensity of light); and (6) β (coeff. of the photoeffect, identical with the quantum yield if I is measured in number of quanta per sec). Since it is not known beforehand which of these magnitudes are essential for a given experiment, it is not sufficient to study the complex magnitude of stationary photoconductivity without paying attention to each of the above factors, at least to the temp. dependence of (1) life τ; (2) quantum yield β; and (3) stationary photoconductivity $\Delta\sigma_{stat}$. The method employed was described in a previous paper by Zhuze and Ryvkin [*Dokl. Akad. Nauk, SSSR*, **58**, 1629 (1947)]. The present paper deals with the temp. dependence of the quantum yield in the case of Cu_2O. The life of the carriers of photocurrent rises steeply as temp. falls, the quantum yield decreasing at the same time. The law for the former relationship is $\tau \sim \exp(E/2kT)$ (E being the dissociation energy value from the expression $\sigma \sim \exp(-E/2kT)$; the law for the latter relationship is $\beta \sim \exp(-E/2kT)$ (for the "low-temp." region below 40°). Finally the stationary photoconductivity in the "high-temp." region is $\Delta\sigma_{stat} \sim \exp(E/2kT)$. Life of photocurrent carrier in Cu_2O has a value between $1{\cdot}3\times10^{-4}$ and 5×10^{-5} sec. F. LACHMAN

537.312.

2461. Kinetics of the photo-conductivity of semiconductors. V. E. LASHKAREV. *J. Exp. Theor. Phys. USSR*, **19**, 876–86 (*Oct.*, 1949) *In Russian.*

The methods of investigating the kinetics of the photoconductivity of semiconductors are critically surveyed and the semi-empirical theory of linear photoconductivity considered for the cases of alternating photocurrent under symmetrically modulated light, bridge-method of alternating photocurrent and equal rectangular light pulses. The theory of non-linear photoconductivity is then developed for a number of special cases and quantative relations suitable for check by experiment are given.

B. F. KRAUS

537.312.

2462. Non-linear photo-conductivity of PbS-photo-resistance. V. E. LASHKAREV, I. R. POTAPENKO AND G. A. FEDORUS. *J. Exp. Theor. Phys., USSR*, **19**, 887–98 (*Oct.*, 1949) *In Russian.*

The photoconductivity of PbS photo-resistances was investigated between +20° and −100°C, in a wide interval of irradiation and over the linear and non-linear range. The differential method was used [see preceding Abstr.]. The inverse characteristic time for moderate illumination is a linear function of the photocurrent, i.e. on the basis of hole-theory, the recombination probability is $\propto$ no. of encounters between electrons fixed on localization levels and free holes. Probability of recombination owing to electron-hole encounter has 2 terms, the first of which is independent, the second dependent on temp. Thus there are 2 recombination mechanisms, one not requiring activation energy, the second, an energy $\sim 0{\cdot}4$ eV. The adherence levels for the PbS photo-electrons are the acceptor levels responsible for the dark photoconductivity. Adherence levels for holes filled with electrons exist at the absolute zero. For one of the specimens, such a level is located at 0·13 eV. For the same specimen, the acceptor levels lie at 0·19 eV. The PbS in the photo-resisting condition is very different from "ordinary" fusion-produced PbS, the latter having a high conductivity with a "metallic component"; the photoconducting PbS low conductivity without metallic component.

B. F. KRAUS

537.312.62

2463. Electromagnetic induction in a superconductor. W. V. HOUSTON AND C. F. SQUIRE. Letter in *Phys. Rev.*, **76**, 685–6 (*Sept.* 1, 1949).

A Pb ellipsoid was spun at from 3 000 to 9 000 r.p.m. in a vertical field of 30 to 70 gauss. The e.m.f. between two points on the surface fell from its expected value when the Pb was normal to less than 5% of this value when the Pb became superconducting. Preliminary results [*Science*, **109**, 439 (1949)] which suggested no reduction of e.m.f. in the transition

ere shown to be due to heat generation at the earings which caused the temp. to be above that of e liquid He bath. [See also Wexler and Corak, llowing Abstr.]. D. SHOENBERG

537.312.62

2464. Electromagnetic induction in a superconductor. A. Wexler and W. S. Corak. Letter in *Phys. Rev.*, 75, 432–3 (*Aug.* 1, 1949).

The e.m.f. between the axis and periphery of a Pb phere rotating in a vertical magnetic field H was measured both for varying H at constant T and for powering T at constant H. The e.m.f. had its expected value in the normal state, but in the superconducting state, contrary to a previously reported result [Houston and Squire, *Science*, **109**, 439 (1949)], but in agreement with the Meissner effect there was no e.m.f. D. SHOENBERG

537.312.62

2465. On the penetration of a magnetic field into a superconductor. G. M. Avakyants. *J. Exp. Theor. Phys., USSR*, **19**, 946–9 (*Oct.*, 1949) *In Russian.*

An approximate method of calculation based on the Londons' equation is described. D. SHOENBERG

537.312.62

2466. Superconductivity and electrodynamic potential. M. v. Laue. *Z. Phys.*, **125** (*Nos* 7–10) 517–30 (1949) *In German.*

The electrodynamic potential is generalized to embrace superconductors in magnetic fields, including persistent currents in rings, but not currents fed into superconductors from outside. The work done by a quasi-stationary magnetic field is calculated both for the case where the bodies belonging to the field change their position and for phase transitions between superconductive and normal state. H. LONDON

537.312.62

2467. Surface impedance of normal and superconductors at 24 000 megacycles per second. E. Maxwell, P. M. Marcus and J. C. Slater. *Phys. Rev.*, **76**, 1332–47 (*Nov.* 1, 1949).

The surface impedance of Sn at 24 000 Mc/s has been investigated from 2°K to 300°K, including both the superconducting and normal states, by means of a resonant cavity technique. The experimental techniques are described and the data for the normal state discussed in terms of the theory of the anomalous skin effect given by Reuter and Sondheimer. Agreement is found between the general features of the theory and the data although numerical estimates for the number of free electrons appear too low. The superconducting data are analysed in terms of a theory which combines the London and the Reuter and Sondheimer theories. The variation of penetration depth, λ, with temp. is found to be in agreement with other determinations. The best value for λ_0 is estimated at 10^{-5} cm. A.

537.312.62

2468. Experiments on the superconductive transition. D. K. C. MacDonald and K. Mendelssohn. *Proc. Roy. Soc. A*, **200**, 66–84 (*Dec.* 22, 1949).

The change of electrical resistivity at the transition between the superconductive and the normal state in a longitudinal magnetic field has been investigated systematically. By successive elimination of a number of disturbing factors an experimental procedure has been developed which yields consistent and reproducible results. The metals Pb, Hg and Sn have been investigated in this manner. Contrary to the accepted view it has been found that under "ideal" conditions the transition is not discontinuous. There exists a range of temp. and mag. field in which the resistance changes gradually from normal to zero and vice versa. The extent of this transition region was found to grow rapidly with increasing absolute value of the mag. field. Under conditions closely approximating the "ideal" longitudinal case transitions with hysteresis were never observed. However, it could be shown that resistance hysteresis and discontinuous resistive changes are produced by deviation from the longitudinal case owing to unsuitable geometrical shape of the specimen. The general conclusion has therefore been reached that the resistance of a pure superconductor in a longitudinal field changes continuously in transition between the superconductive and the normal state. The significance of the results has been discussed and further experiments have been proposed. A.

537.312.62 : 536.21

Heat transport in superconductors. *See Abstr.* 2394

537.312.62 : 536.531

Superconductivity of lead films. *See Abstr.* 2426

537.312.62 : 538.244

The magnetization of superconducting plates in transverse magnetic fields. *See Abstr.* 2576

537.322.2 : 621.315.5.066.6

2469. The theory of the Thomson effect in electrical contacts. P. M. Davidson. *Proc. Instn Elect. Engrs, Pt I*, **96**, 293–5 (*Nov.*, 1949).

A general theorem is given concerning the influence of the Thomson effect on the location of the max. temperature in an electrical contact. Its application to the theory of fine transfer in electrical contacts is discussed. A.

ELECTRIC DISCHARGES 537.52

537.523.3

2470. Investigation of the breakdown of air in gaps under corona at low voltage. M. A. Bak, A. S. Zingerman and N. N. Nikolaevskaya. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 2) 249–52 (1949) *In Russian.*

In earlier work it was shown that in an inhomogeneous field the delay of the flashover of the air gap consists of a "dead" (idle) period during which nothing happens in the gas and a "working" period, during the development time of the flashover. The delay of the flashover obeys a statistical law, whose character depends on the voltage applied. At high over-voltages the delay follows the normal law, the "dead" period being absent. At reduced voltages the statistics of the delay become more complicated. The investigation was mainly concerned with establishing the relation between the current impulses and the following factors: voltage amplitude, gap length and polarity. It was shown that the processes causing the

current impulses are identical with those resulting in the formation of the canal of the leader. There is a close similarity between the statistics of the current pulses and that of the pulseless discharges (leader-type). It is concluded that in spark gaps under corona the flashover below a certain critical voltage has a discontinuous character, where the formation of the ionized canal (leader) is concerned and is accompanied by short lasting current pulses (of the order of 1/10 000 mA) each of which corresponds to an independent leader. B. F. KRAUS

537.523.4

2471. Impulse breakdown in the 10^{-9}-sec. range of air at atmospheric pressure. R. C. FLETCHER. *Phys. Rev.*, **76**, 1501–11 (*Nov.* 15, 1949).

The formative lag of spark breakdown has been measured over the range from 0·5 to 50×10^{-9} sec using transmission line circuits in conjunction with the micro-oscillograph. It is found to be a function only of the applied field (independent of gap-width) for the shorter times (high fields), but to increase for decreasing gap-widths for the longer times (low fields). A calculation of the formative lag is presented which is based on the assumption that it consists mainly of the time for a single electron avalanche to build up a space-charge field comparable with the applied field. This predicts the observed formative lags within the experimental accuracy of the measurements over the entire range used. The increasing times for decreasing gap-widths for the longer times is interpreted as the transition from a single avalanche to a multiple avalanche mechanism of breakdown. The critical field where this transition takes place for a given gap-width is computed and found to predict the observed critical fields within the experimental accuracy. The good agreement between theory and experiment enables a more reliable prediction than has previously been possible of the critical gap-width above which the threshold field is determined by a single avalanche mechanism. A sharp drop in the rate of fall of the breakdown voltage is observed for the shorter times. It is suggested that this may be a change in the mechanism of electron release from the cathode. A.

537.523.74 : 621.3.015.5 : 621.316.933

2472. The conductivity of discharge gaps in the de-ionized state. I. G. KESAEV. *J. Tech. Phys., USSR*, **19**, 1276–91 (*Nov.*, 1949) *In Russian.*

Measurements of the conductivity of a gas after a h.f. impulse discharge between flat electrodes in He, Ne, A, H and air are discussed. The complexity of the post-discharge conductivity was established, the capacitive component of which is > the resistive component. He exhibits anomalous behaviour, as conductivity increases directly after the discharge to reach a max. after a fraction of 1 μsec. B. F. KRAUS

537.525

2473. On the influence of a static magnetic field on electrodeless high frequency gas discharge in hydrogen. B. KOCH AND H. NEUERT. *Z. Naturforsch.*, **4a**, 456–63 (*Sept.*, 1949) *In German.*

This was investigated under pressures of 1 to 50 10^{-3} mm Hg. The discharge is greatly affected by the static magnetic field strength, showing resonance behaviour. The resonances depend on gas pressure, dimensions of the container, and the h.f. used. Plasma oscillations in resonance with the h.f. are proposed, in which resonance is effected by change in electron concentrations. The field strength has a minimum at resonance positions; for high anode voltages, sharp high field strengths occur for spherical discharge vessel. The analogy with experiments on ferro- and paramagnetic properties of solids or liquids with h.f. suggest a possible similar explanation for the present investigations. J. JACOBI

537.52

2474. Limits for the diffusion theory of high frequency gas discharge breakdown. S. C. BROWN AND A. D. MACDONALD. *Phys. Rev.*, **76**, 1629–33 (*Dec.* 1, 1949).

A study is made of the limits within which diffusion phenomena control the breakdown of a h.f. discharge. The discussion is based on proper variables found by dimensional analysis, using the parameters $p\Lambda$, $p\lambda$ and $E\Lambda$, where p is the pressure, Λ the characteristic diffusion length, λ the wavelength of the excitation and E the breakdown electric field. The limits of applicability of the diffusion theory are found to be a uniform field limit, a mean free path limit, and an oscillation amplitude limit. Within these limits, a single function for the effective breakdown voltage $E\Lambda$, and the energy per mean free path, E/p, correlates the breakdown voltages for all published data tested covering a wavelength range from 10 cm to 17 000 cm. A.

537.52

2475. High frequency gas discharge breakdown in hydrogen. A. D. MACDONALD AND S. C. BROWN. *Phys. Rev.*, **76**, 1634–9 (*Dec.* 1, 1949).

This has been treated theoretically on the basis of the Boltzmann transport equation. Inelastic collisions are taken into account as a loss term in the Boltzmann equation and measured values of the ionization efficiency are used in the integral determining the ionization rate. The energy distribution function for electrons may be expressed in terms of the confluent hypergeometric function and simple exponentials. The ionization rate and diffusion coeff. are calculated using these distribution functions and kinetic theory and are combined with the diffusion equation to predict breakdown electric fields. These predicted electric fields are compared with experimental values measured at 3 000 Mc/s. They are also compared with older measurements by other workers at frequencies ranging from 3 Mc/s to 100 Mc/s. The breakdown equation calculated from kinetic theory and using no gas discharge data other than the collision cross-section measurements and involving no adjustable constants predicts breakdown electric fields well within the limits of accuracy determined by these cross-sections over a large range of pressure, container size and frequency of applied field. A.

537.52

2476. Breakdown in cold-cathode tubes at low pressure. F. G. HEYMANN. *Proc. Phys. Soc. Lond. B*, **63**, 25–41 (*Jan.*, 1950).

When, in cold-cathode discharge tubes, electrode spacings and surface areas deviate from the ideal of infinite parallel planes, it is found that the breakdown

voltage between electrodes increases. This is explained as a decrease in the effective η of the gas due to loss of electrons and positive ions by diffusion to the walls of the container. The loss factor per unit potential difference is shown theoretically to be inversely $\propto$ the field strength and tube radius, although this is not fully verified by experiment. Paschen curves obtained experimentally for K and Ni cathodes in A and in a Ne–A mixture at low pressures are shown and, from these, values of γ for the two cathode surfaces are obtained as a function of E/p_0. The apparatus used for measuring breakdown voltage is described. Earlier theories of statistical and formative time delays are extended to cover the case of a rising overvoltage and also the case where the primary electrons appear in bursts as with ionization by α-particles. The shape of the statistical distribution curve is an indication of whether the primary electrons have been produced singly or in bursts. The overvoltage ΔV of breakdown due to formative lag and the rate of rise of the uniformly increasing applied voltage V are found to bear the relation $\Delta V \propto \sqrt{(dV/dt)}$. This has been experimentally verified. A.

537.525 : 538.563

The spherical electromagnetic proper oscillations of spaces which contain plasma. *See Abstr.* 2590

537.525.4 : 537.564 : 621.3.015.52

2477. A study of impulse breakdown in air at low pressures from successive cathode ray oscillograms. B. GÄNGER. *Arch. Elektrotech.*, **39** (*No.* 8) 508–34 (1949) *In German.*

Experiments on breakdown up to 50 kV in a point-to-sphere field are described, and discussion covers formative and statistical time lags (down to 10^{-8} sec), effects of point polarity, discharge mechanism, voltage collapse, and channel growth, as well as previous work. At all pressures used time lags had a statistical distribution, and no streamer-to-Townsend mechanism transition phase was found. Conclusions reached were that rapid channel build-up on breakdown only occurs with an overvoltage, and that the Townsend mechanism involving positive ions is altogether a possible one. On impulse breakdown, voltage was only slightly dependent on polarity; whereas in static cases at moderate gas pressures a negative point had a much lower voltage than a positive point. This was attributed to effect of different mechanisms of secondary ionization: with a positive point the mechanism is the same for short as for long discharge paths, but with a negative point cathode emission which is effective with short paths is replaced at long paths by a gas ionization process. The "step" in the voltage on breakdown was observed at all presssures, and its mechanism is discussed. F. LLEWELLYN JONES

537.525.5

2478. Double-probe method for determination of electron-temperatures in steady and time-varying gas discharges. E. O. JOHNSON AND L. MALTER. Letter in *Phys. Rev.*, **76**, 1411–12 (*Nov.* 1, 1949).

A new method for studying decaying, low-pressure, plasmas with probes is described. Two probes are connected together through a resistor and a variable potential source, the whole circuit being at a floating potential. A c.r.o. is connected across the resistor. The analysis of the experimental data is given, and results are quoted for an A-filled hot-cathode diode.

J. D. CRAGGS

537.525.8

2479. Normal glow discharge in mixtures of inert gases. P. N. CHISTYAKOV. *J. Tech. Phys., USSR*, **19**, 1154–60 (*Oct.*, 1949) *In Russian.*

The dependence of V and j/p^2 on the composition of mixtures of inert gases was investigated by working with fused-off vessels and deposition of active substances on the cathode by atomization. This produces particularly favourable conditions for gas purification and homogeneous cathode surface. The considerable influence was established of small admixtures of A on the value of V for Ne + A mixtures, and the much lower influence of such additions of A for He + A mixtures, although the character of the relation is analogous. j/p^2, however, is actually independent of small A-admixtures in He, whereas additions of 10% A in He have a great influence on its magnitude. (V = normal cathode fall, j = normal current density, p = pressure.)

B. F. KRAUS

537.525.8

2480. A possible explanation of the Joshi effect. S. SHAMIM-AHMAD AND M. V. RAMANAMURTI. Letter in *Curr. Sci.*, **18**, 416–17 (*Nov.*, 1949).

It is suggested that the Joshi effect [see Abstr. 1786, 2049, 2566 (1944)], etc., may be due to the formation, in the ozonizer tube, of a "wall complex" which may be ionized in the discharge with production of free electrons or which may suffer photo-dissociation, when the external radiation is used, with the formation of negative ions. The consequences of this theory are considered in relation to exptl. results and there is general qualitative agreement. A bibliography of 29 references is included. J. D. CRAGGS

537.525.8

2481. Wall influence in the production of the Joshi effect in chlorine under silent electrical discharge. B. M. SHUKLA. *J. Phys. Coll. Chem.*, **53**, 1239–55 (*Nov.*, 1949).

Describes further expts. with an ozonizer discharge tube, operated at 50 c/s and containing Cl at 170 mm Hg. The tube could be inverted to bring a quantity of powdered glass ("wall material") into the discharge space, and the characteristics of normal and wall discharges were then studied as a function of various parameters. A detailed discussion is given, but the exact mechanism of the Joshi effect [see, e.g., Abstr. 7033–40 (1949)] appears to be unknown. J. D. CRAGGS

X-RAYS 537.531

537.531 : 535.331

2482. A contribution to the theory of soft X-ray emission bands of sodium. P. T. LANDSBERG. *Proc. Phys. Soc. Lond. A*, **62**, 806–16 (*Dec.*, 1949).

A wave-mechanical treatment of the $L_{II,III}$ emission

spectrum of Na is given, taking into account (i) the broadening of the energy levels in the conduction band due to electron collisions; (ii) the lowering of the potential energy of the electron about to make transition into an inner shell of an ion, due to electrostatic attraction. The first problem is treated in the free electron approximation, using a model suggested by Skinner, and the theoretical curve has a "tail," as found experimentally. The calculation shows that a modification of the wave functions of electrons in a free electron model may be required, and this possibility is discussed. In the second problem, the depression in the electron potential is approximated by using a spherical potential well in the neighbourhood of the ion. The first effect proves to be the more important one, and there is good agreement with experiment. A.

537.531 : 535.343

2483. The calculation of X-ray mass absorption coefficients. J. A. VICTOREEN. *J. Appl. Phys.*, **20**, 1141–7 (*Dec.*, 1949).

An empirical method is given. Complete tables of constants are presented for calculating μ/ρ for all elements and for wavelengths $<$ the K critical absorption wavelength. Partial tables give constants for wavelengths between the L_1 and M_1 critical wavelengths. Calculated coeffs. are given for the common elements. A.

537.531 : 535.343

2484. The interpretation of X-ray absorption spectra of solids. Y. CAUCHOIS AND N. F. MOTT. *Phil. Mag.*, **40**, 1260–9 (*Dec.*, 1949).

Some recent experimental results on the fine structure of the X-ray absorption edges of solids are discussed. For many solids a pronounced max. at the absorption edge may exist. Various possible causes are discussed. One of these is the formation of exciton levels which are energy levels unformed until the electron is removed from the X-ray level, and which are caused by the field round the point where the charge is missing. L. S. GODDARD

537.531 : 535.343

2485. Penetration and diffusion of X-rays through thick barriers. II. The asymptotic behavior when pair production is important. U. FANO. *Phys. Rev.*, **76**, 739–42 (*Sept.* 15, 1949).

The methods of a previous paper [Abstr. 301 (1950)] are modified to cover the high energy X-rays which are strongly absorbed by pair production. The variation of intensity with depth of penetration is then expected to follow a law of the type $x^{-5/6}\exp.(-\mu_m x + bx^{\frac{1}{2}})$. A.

537.531 : 535.343 : 539.166

2486. Penetration and diffusion of hard X-rays through thick barriers. III. Studies of spectral distributions. P. R. KARR AND J. C. LAMKIN. *Phys. Rev.*, **76**, 1843–5 (*Dec.* 15, 1949).

Two kinds of spectral distributions of γ-rays are discussed. These are (1) spectra found in an infinite medium with a uniformly distributed monochromatic source, and (2) equilibrium spectra obtained in an artificial penetration problem. Curves are shown for various media and for various energies of the source photons. The relations of these spectra to the general problem of γ-ray penetration is discussed. A.

537.531 : 535.43

2487. Theory of the diffuse small angle X-ray scattering in colloidal systems. G. POROD. *Z. Naturforsch.*, **4a**, 401–14 (*Sept.*, 1949) *In German.*

A survey of the theories of small angle X-ray scatter is given for (*a*) diluted, (*b*) closely packed systems and (*c*) for external small angle scatter. The latter refers to strongly absorbent specimens, where the contribution of the scattering effect takes place predominantly within a thin surface layer having colloidal dimensions in one direction. The discussion of the diluted systems is based on the approximation methods by Guinier and Kratky and deals with 3 basic types of particle shape, namely globules, rods and discs, which differ mainly by the relative decrease of intensity with angle. The treatment of closely packed systems is divided into orientated and disorientated structures and scatter curves for special cases, such as cluster of spheres and disc shaped aggregates are shown. Methods for the calculation of scatter curves for differently shaped systems are given and the conditions for elongated and disordered threads are discussed. R. H. HERZ

537.531 : 535.43

2488. Multiple diffuse small angle scattering of X-rays. D. L. DEXTER AND W. W. BEEMAN. *Phys. Rev.*, **76**, 1782–6 (*Dec.* 15, 1949).

The problem of multiple X-ray scattering from spherical particles of radius $\geqslant$ the wavelength is treated using the Guinier approximate scattering function. The total scattered intensity is found to be a sum of Gaussians in the polar angle with coeffs. dependent on the sample thickness. A method is discussed for determining particle sizes from the variation of the width of the scattering curve with sample thickness. Experimental results are given for two carbon blacks. A.

537.531 : 535.43

2489. Collimation error in small angle X-ray scattering. K. L. YUDOWITCH. *J. Appl. Phys.*, **20**, 1232–6 (*Dec.*, 1949).

It has been shown that excessive error may be introduced in small angle X-ray scattering by the use of an incident beam of finite cross-section. To account for this error the usual procedure has required multiple integrations for rays reaching a single point P on the film from all points within each slit. However, the common effect from both finite slit height and width is a range of scattering angle for rays reaching P. The integrations over each slit dimension are reduced to a single integration over scattering angle, which entails finding the limits of scattering angle. The assumption of a constant distribution of intensity throughout the range allows the range of scattering angle $\delta\varepsilon$ to be taken as a measure of the collimation error. Minimization of $\delta\varepsilon$ permits determination of optimum values of slit height-width ratio. For two slit collimation, it further leads to determination of optimum slit spacing and optimum relative slit sizes. A.

537.531 : 535.43 : 532.7

2490. Generalization of the Born and Green theory of fluids to mixtures of several kinds of molecules. Calculation of the scattering of X-rays. G. FOURNET. *C.R. Acad. Sci., Paris*, **229**, 1071–3 (*Nov.* 21, 1949) *In French.*

[See Abstr. 7045 (1949)]. The Born and Green theory [Abstr. 771 (1947)] is extended to fluids containing m kinds of molecules, and the small-angle scattering is derived for $m = 2$.

A. J. C. WILSON

537.531 : 535.822.9

2491. Wave-lengths suitable for X-ray microscopy of biological specimens. J. L. FARRANT. Letter in *J. Appl. Phys.*, **21**, 63–4 (*Jan.*, 1950).

The advantages are outlined of using longer, more absorbable wavelengths than 1·5 Å for the microscope described in Abstr. 240 (1949): greater contrast with low-absorbing specimens; precision of mirrors less critical; increased critical glancing angle, giving greater speed; simpler focusing using visible light.

537.531 : 537.533 : 537.542

Integrating crystal detectors for high energy photons and particles. *See Abstr.* 2516

537.531 : 539.166

Study of the X-rays of MTh I and MTh II. *See Abstr.* 2661

537.531 : 539.26

2492. X-ray line broadening in metals. W. H. HALL. Letter in *Proc. Phys. Soc. Lond., A*, **62**, 741–3 (*Nov.*, 1949).

The author believes that the diverse opinions of different workers on the explanation of X-ray line broadening in metals can be reconciled in terms of the hypothesis of Dehlinger and Kochendörfer [Abstr. 2694 (1939)] and Kochendörfer [*Z. Kristallograph, A*, **105**, 393 (1944)] that both particle size and stress effects are present simultaneously. This hypothesis is supported by Bragg [Abstr. 4199 (1949)]. If $\beta_P = (\lambda/\varepsilon)\sec\theta$ is the broadening produced by particles of effective size ε [Jones, Abstr. 2491 (1938)], and $\beta = \eta \tan\theta$ is the pure stress broadening due to the effective strain η [Stokes and Wilson, Abstr. 1459 (1944)], then as shown by Wood and Rachinger [Abstr. 3501 (1949)] for commonly occurring line shapes $\beta = \beta_P + \beta_S$ giving $(\beta/\lambda)\cos\theta = (1/\varepsilon) + (\eta/\lambda)\sin\theta$. This curve is plotted from the data of 8 published and one unpublished measurements giving straight lines with intercept corresponding to $\varepsilon \simeq 10^{-5}$ cm, except in one case. This agrees with result of Wood and Rachinger. R. B. SHEPHERD

537.531 : 548.734

2493. Geometrical factors affecting the contours of X-ray spectrometer maxima. II. Factors causing broadening. L. ALEXANDER. *J. Appl. Phys.*, **21**, 126–36 (*Feb.*, 1950).

By applying Stokes' Fourier transform method for the analysis of diffraction maxima it is shown that the pure diffraction contour generated by a crystallite size distribution is often approximated rather closely by the function $1/(1 + k^2\phi^2)$. In the case of the X-ray spectrometer this pure diffraction contour is broadened significantly by the action of 5 geometrical factors: X-ray source width, flat rather than curved sample surface, vertical divergence of the X-ray beam, penetration of the sample by the beam, receiving slit width. The broadening action of each of the factors and the breadth of the final contour generated by the instrument can be deduced by employing the convolution approach suggested by Spencer. [See Abstr. 1053 (1949)]. A.

537.531 : 771.53

2494. The photographic action of X-rays in the 1·3 to 0·01A range. H. HOERLIN. *J. Opt. Soc. Amer.*, **39**, 891–7 (*Nov.*, 1949).

The spectral response of two typical X-ray films was determined as a function of the truly absorbed energy and also as a function of the number of absorbed quanta needed to produce a given optical density. With decreasing wavelength a better utilization of the kinetic energy of the photo and recoil electrons takes place in the process of photographic image formation. The number of absorbed quanta needed to produce the same photographic effect decreases rapidly with decreasing wavelength. Correspondingly the average number of grains made developable per absorbed quantum increases. These data, together with those of the range of electrons in AgBr and of their energy loss per unit path-length permitted the determination of the inherent sensitivity of the average grain. Comparison between the sensitivities to visible radiation, and to X-rays, reveal great differences in efficiencies of latent image formation between films. The average grain of Non-Screen film requires the formation of 210 latent image Ag atoms by photo or recoil electrons, and 105 Ag atoms by exposure to blue light. The corresponding figures for High Speed X-ray film designed for medical work with Ca tungstate intensifying screens are 270 Ag atoms for electrons and only 8 Ag atoms for blue light. This relative inefficiency of direct X-ray exposures is predominantly due to the formation of large amounts of internal latent image. A.

537.531.85

2495. Theoretical calculations of the form and width of the Compton-line. A. KÓNYA. *Hungar. Acta Phys.*, **1** (*No.* 5) 12–24 (1949) *In German.*

Experiments have shown that the Compton line covers a narrow but continuous wavelength band showing a characteristic intensity distribution which reaches its greatest ½-width within the region of noble gases. The width is caused by the fact that Compton scatter does not occur on free and stationary, but on bound electrons in motion. Since wave-mechanical treatment of this problem provides only the distribution of momenta of electrons, du Mond's theory of Compton scattering has been applied to the calculation of the form and width of Compton lines using Fermi–Dirac statistics. In contradiction to the wave-mechanical treatment this method is advantageous for the calculation of Compton lines of heavy atoms. The theoretical results of the ½-widths of the Mo K_α lines for Ne are compared with empirical values based on Thomas–Fermi, Hartree–Dougall and Duncanson–Coulson eigenfunctions, and it is shown that the statistical treatment of the latter gives the closest approach to the empirical value.

R. H. HERZ

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

2496. Measurement of betatron guiding fields during electron ejection. E. C. GREGG, JR. Note in *Rev. Sci. Instrum.*, **20**, 841 (*Nov.*, 1949).

The magnetic field is measured at different radii as a function of time by connecting a movable probe coil to a c.r.o. through a simple integrating circuit, using a linear sweep. T. G. PICKAVANCE

537.533 : 537.531 : 537.542

Integrating crystal detectors for high energy photons and particles. *See Abstr.* 2516

537.533 : 621.384.6

2497. Betatrons with and without iron yoke. A. BIERMAN AND H. A. OELE. *Philips Tech. Rev.*, **11**, 65–78 (*Sept.*, 1949).

A description of two betatrons built in the Philips Laboratory at Eindhoven. The first has been constructed on conventional lines; the required magnetic flux and the magnetic directing field which must exist along the circular orbit of the electrons, are generated in an air-gap of an iron circuit excited with a.c. at 500 c/s and provided with carefully laminated pole pieces of a special shape. This apparatus weighs 270 kg and generates in 500 short pulses/sec electrons having an energy of 5 MeV. In the second apparatus the magnetic field is obtained by means of air coils through which the discharge current from a condenser battery flows. Only a small iron core is introduced in the coils. Thanks to this core it has been easy to satisfy the flux requirement and, owing to the saturation of the iron, it has also been possible to obtain in a simple manner the desired contraction of the electron orbit at the end of each acceleration period. The discharge has the form of a strongly damped oscillation with a frequency of 2 500 c/s, whilst the reactive power of the first oscillations amounts to 250 MVA. This apparatus has been constructed for supplying electrons at 9 MeV in a few very short pulses at the beginning of the discharge, which can be repeated at intervals of ~ 1 sec. Provisional measurements indicate that the number of electrons fully participating in the acceleration process is much greater in this apparatus than in the betatron with iron yoke. This is due, among other things, to the high energy gain per loop of the electron (240 eV), limiting the total distance to be travelled by the electrons to 30 km (60 000 loops in the toroidal accelerating tube). The air-coil betatron weighs only 50 kg. A.

537.533 : 621.389 : 621.384.6

2498. Electronics applied to the betatron. T. W. DIETZE AND T. M. DICKINSON. *Proc. Inst. Radio Engrs*, **37**, 1171–8 (*Oct.*, 1949).

Injection problems are discussed, and a 70 kV electron gun for a 50 MeV betatron is described. A circuit for producing a shaped injector pulse is given. An account is given of control circuits for the injection and extraction processes, and of a megavoltmeter and high- and low-level X-ray intensity monitoring circuits. J. D. CRAGGS (R)

537.533.7

2499. The reflection of fast electrons [by solids] W. BOTHE. *Z. Naturforsch.*, **4a**, 542–5 (*Oct.*, 1949). *In German.*

This was investigated for electrons with primary energies 370 and 680 keV, the reflecting solids being graphite, Al, Cu, Sn and Pb. The energy distribution of the reflected electrons was determined; the positions of the max. show only slight dependence on the primary energy. The reflection coeff. was found to increase with atomic number. A qualitative interpretation of these results is given.

E. P. WOHLFARTH

537.533.72 : 538.11

Electron optical mapping of electromagnetic fields. *See Abstr.* 2566

537.533.72 : 538.221

Fringe fields of ferromagnetic domain. *See Abstr.* 2568

537.533.72 : 621.385.833

2500. A three-stage electron microscope with stereographic dark field, and electron diffraction capabilities. M. E. HAINE, R. S. PAGE AND R. G. GARFITT. *J. Appl. Phys.*, **21**, 173–82 (*Feb.*, 1950).

An electron microscope is described in which a range of magnifications between 1 000 and 100 000× can be covered continuously. This is achieved through the use of an intermediate projector lens. The principles of design are briefly discussed and the construction of the microscope and the high frequency-operated 100 kV power unit is dealt with in some detail. The instrument is provided with objective apertures to enhance image contrast and to permit operation with dark field illumination. Data is given relating to the electron optical system and it is shown how the instrument can be used to obtain electron diffraction patterns characteristic of small areas of a specimen under microscopic observation. The alignment procedure is briefly described and some typical micrographs are shown. A.

537.53

2501. Voltage stabilization for electrostatic generators using an electron gun. S. J. BAME, JR. AND L. M. BAGGETT. Note in *Rev. Sci. Instrum.*, **20**, 839–40 (*Nov.*, 1949).

The particle energy is stabilized by sending an electron beam of 10–20 μA up the accelerating tube; the electrons produce a variable loading on the generator, controlled through an electronic circuit by the position of the ion beam emerging from a 90° magnetic analyser. This method, which has a delay time $\sim 10^{-6}$ sec, has been improved by using a 3 electrode electron gun in place of a modified triode valve as a source of electrons [see *Phys. Rev.* **70**, 882 (1946)]. A magnetic lens produces a electron focal spot size of 5 mm at 18 in, with 800 V on the anode. The ion beam intensity is held steady to within 10%. T. G. PICKAVANCE

537.53

2502. Betatron-starting in electron synchrotron J. J. WILKINS. *Phil. Mag.*, **41**, 34–53 (*Jan.*, 1950).

The magnetic design of betatron-starting flux bars for electron synchrotrons is considered in relation to the principles governing efficient initial electron

jection and efficient betatron-synchrotron transition. brief discussion of betatron-synchrotron transition eory is included, in order to show how flux bar rformance may be specified therefrom. A design rocedure is derived for determining the essential ux bar dimensions, approximate corrections being ade for skin effect in the laminated material of the ars. To illustrate the principles discussed in the ain paper, the results of some detailed performance lculations on the 375 MeV Glasgow University nchrotron are given in an Appendix. A.

537.534

503. Radiofrequency mass spectrometer. W. H. ENNETT. *J. Appl. Phys.*, **21**, 143–7 (*Feb.*, 1950).

A mass spectrometer tube using velocity selection described. The tube has parallel plane grids made ith knitted wire nets with a large percentage of pen area. The grids are arranged in groups of ree, and radiofrequency alternating potential is pplied to the middle grid of each group. Stopping otentials are used to turn back all ions except those ith the selected mass. The spectrometer has sufficient esolution for ordinary gas analysis requirements nd is simpler, more compact, and more rugged than nagnetic beam deflection devices. A.

537.534 : 621.384.6

504. On the capture of particles into synchrotron rbits. T. R. KAISER. *Proc. Phys. Soc. Lond. A*, 3, 52–66 (*Jan.*, 1950).

A theory is developed for the capture of particles nto synchrotron orbits when the r.f. accelerating oltage rises from zero to its max. value in a finite ime. It is shown that if this time of rise is sufficiently ong, all particles originally occupying a band of width $1/\sqrt{2}$ times the max. width of the final stable egion for synchrotron phase oscillations will be aptured, irrespective of the initial phase at which hey enter the accelerating gap. This conclusion eems to agree with the observed characteristics of xisting electron synchrotrons. A.

537.534 : 621.384.6

505. Experiments on electron capture and phase tability in a 14 MeV. synchrotron. T. R. KAISER AND J. L. TUCK. *Proc. Phys. Soc. Lond. A*, **63**, 67–74 (*Jan.*, 1950).

Experiments were made by interrupting the r.f. ccelerating voltage for intervals during the acclera- ion in a synchrotron, and observing the effects on he output. The process of capture is found to be nore efficient than would be expected for an instan- aneously developed r.f. accelerating voltage. The ynchrotron acceleration may be interrupted for a hort period without losing more particles than would e accounted for by contraction of the beam radius uring the interruption, so that for sufficiently short eriods of interruption the loss is negligible. This emonstrates that the phase at which electrons enter he resonator during capture is of no consequence nder the conditions prevailing. The results are in uantitative agreement with a theory by Kaiser [preceding Abstr.] which takes into account the inite rate of rise of resonator voltage, and with the eneral theory of synchrotron stability. A.

537.534.72

2506. The different types of trajectories of charged particles in inhomogeneous axially symmetrical magnetic fields. J. LAFOUCRIÈRE. *C.R. Acad. Sci., Paris*, **229**, 823–5 (*Oct.* 24, 1949) *In French.*

If there is a strong field gradient, viz., if rH decreases as r increases, 3 types of trajectories in the plane of symmetry are possible: (1) Aperiodic, eventually escaping from the region of the field; this applies to high energy particles. (2) For a given source position and ($H\rho$), one ray becomes asymptotic to a circle centred on the axis of symmetry. (3) Particles of relatively low energy describe trochoids, in which for the slowest particles the loop width exceeds the precession, whilst the converse holds for faster particles. For a given ($H\rho$), all rays of type (3) initially making small angles with the circle, centred on the field axis and passing through the source, follow the same trochoid; thus a new type of focusing arises. J. C. E. JENNINGS

537.534.72

2507. Inelastic scattering of deuterons. J. R. HOLT AND C. T. YOUNG. Letter in *Nature, Lond.*, **164**, 1000 (*Dec.* 10, 1949).

The angular distribution of 7·5 MeV deuterons scattered inelastically from Al and Mg was measured. Excitation energies of $0{\cdot}99 \pm 0{\cdot}05$ and $2{\cdot}17 \pm 0{\cdot}05$ MeV for Al, $1{\cdot}36 \pm 0{\cdot}05$ MeV for Mg were observed, in agreement with other work [Abstr. 1013 (1950)]. No inelastic scattering was observed from C and Au, but a small group was observed from Ni, excitation energy $0{\cdot}82 \pm 0{\cdot}05$ MeV. B. ROSE

537.534.75

2508. Calculation of proton ranges in materials of low atomic weight. R. GLOCKER. *Z. angew. Phys.*, **1**, 179–81 (*Sept.*, 1948) *In German.*

The stopping no. B as a function of proton energy E can be approximately represented by AE^n, where A and n are constants, or (better) by $a \log E + b$, where a and b are constants. By integration of E/B, the range can be found. The 2nd formula is useful for calculating ranges in media containing different types of atoms. Both formulae give agreement (to within a few %) with the exact theoretical range for initial proton energies from 1 to 15 MeV [cf. Abstr. 1236 (1948)]. A. P. FRENCH

537.534.75

2509. The stopping power for protons in several metals. S. D. WARSHAW. *Phys. Rev.*, **76**, 1759–65 (*Dec.* 15, 1949).

The rate of energy loss of low velocity (i.e., from 50 to 400 keV) protons has been measured for Be, Al, Cu, Ag and Au. Agreement with previous measurements at higher velocities (> 400 keV) is good. The stopping measurements were made on foils prepared by an evaporation technique and are believed to be more accurate than measurements made on the usual (hammered or rolled) foils; the results give a value for stopping about 15% higher (in Au) and about 7% lower (in Al) than those published by Wilcox [Abstr. 2128 (1949)]. A comparison to existing theory at very low and at high velocities (the critical velocity being defined as $e^2/\hbar$) was made

with good agreement shown at the low end. The high end theory is of doubtful validity and gives a stopping power about 10% > observed. It is argued that this discrepancy cannot be accounted for by a proton charge < unity due to the electron capture-loss process. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

2510. A simplified emission regulator for mass-spectrometer ion sources. E. B. WINN AND A. O. NIER. *Rev. Sci. Instrum.*, **20**, 773–4 (*Nov.*, 1949).

A simplified electron emission regulator has been developed which operates by controlling the space current instead of the filament heater current. No vacuum tubes are used, but the performance is comparable with that of electronic regulators. A.

537.542 : 621.385.18 : 621.396.615.12

2511. Plasma oscillator. G. WEHNER. Letter in *J. Appl. Phys.*, **21**, 62–3 (*Jan.*, 1950).

The tube has a grid totally enclosing the cathode, a "repeller" opposite the grid, and an anode outside the beam. Thin velocity-modulating layers are formed near the grid and repeller surfaces. Frequency of oscillations is varied from 800 to 4 000 Mc/s by variation of anode voltage and current.

537.542

2512. A study of the deterioration of methane filled Geiger–Müller counters with external cathodes. D. BLANC. *J. Phys. Radium*, **10**, 411–14 (*Dec.*, 1949) *In French.*

Describes expts. with an external cathode (graphite on glass) counter in which 2 separate cathode segments, besides the guard rings at the ends of the counter, could be used. For the particular tubes used, the counting lives were from 6×10^7 to 2×10^8 counts and during life the starting voltages increased and the plateaus shortened. By leaving one of the cathode segments idle during operation of the other segment, it was found that at the end of the useful life of the latter, the former gave characteristics closely similar to the initial properties of the used cathode. It was therefore concluded that the deterioration was due to localized changes of the inside wall of the glass tube. Details of the various counter characteristics are shown graphically.

J. D. CRAGGS

537.542

2513. Dead times of self-quenching counters. B. COLLINGE. *Proc. Phys. Soc. Lond. B*, **63**, 15–24 *Jan.*, 1950).

Experiments on Geiger counters are described in which localization of the ion sheath was brought about by reducing the wire potential immediately after each count. The effect on the dead time is discussed. The dead time of a counter 30 cm long was found to be 20 μsec and independent of the counting rate up to $1\cdot8\times10^6$ counts per min. The reduction of the dead time of short counters was also investigated. A.

537.542 : 537.55

2514. On the photo-sensitivity of neon lamps an their use in cosmic-ray circuits. O. PARKASH. Lett in *Curr. Sci.*, **18**, 400–1 (*Nov.*, 1949).

The striking potentials of 3 types of commerci gas-filled discharge tubes [GEC: NE–17, NE–2 (neon E5541–A–F–36 (argon)], measured under differe conditions of illumination from an Hg-vapour lam were found to be considerably reduced by dire illumination, less with a blue filter, and unchange with green and yellow filters, from those with stra light only; the running potential and current we unaffected. It is suggested that Ne tubes which mu be used in cosmic-ray (e.g. coincidence) circui should be painted red to eliminate the effect of lig [but see Abstr. 1889 (1945)]. A. O. STANESE

537.542 : 539.1(

2515. On the conductivity produced in CdS crysta by irradiation with gamma-rays. R. FRERICH *Phys. Rev.*, **76**, 1869–75 (*Dec.* 15, 1949).

By combining the theory of secondary photo currents developed by Hilsch, Pohl, Schottky an others, with the model of a crystal phosphor t Johnson and Seitz and by Riehl and Schoen a theor of the photoconductivity in CdS crystals is give The theory agrees qualitatively with the results previous and present experiments. A quantitati energy scheme has been determined from measur ments of the emission and absorption spectra of the crystals. According to the new determined sign the thermal e.m.f.: CdS against Cu, the photocurre in CdS is predominantly carried by electrons. Th dark current follows the usual law: $\log\sigma \propto 1/T$ wit the constants $\varepsilon = 0\cdot67$ eV and $\sigma_0 = 1\cdot7\times10^1$ mho cm^{-1}. In accordance with the theory the fina current reached after prolonged irradiation is $\propto$ th square root of the intensity of irradiation. The fina current follows Ohm's law. The initial slope of th decay curve is $\propto$ the intensity of irradiation. Undd periodical irradiation with γ-rays the amplitude of th resulting alternating current slowly increases to final value. If the electric field is temporarily remove the original conductivity is slowly restored. When CdS crystal is heated and then cooled to liquid a temp. irradiation produces a small primary current $< 10^{-13}$ A at first. With continuous irradiation an after a slight delay this current suddenly increase until it reaches a constant value of 10^{-8} A.

537.542 : 537.531 : 537.53

2516. Integrating crystal detectors for high energ photons and particles. R. S. ALGER. *J. Appl. Phys* **21**, 30–6 (*Jan.*, 1950).

Three of the alkali halides, LiF, KBr and NaC were examined. Dosage measurements were base on the number of colour centres formed in singl crystals under X- and cathode-ray bombardmen Exposures of 20 to 10^4 r (30 kV X-rays) were measure photoelectrically and 10^5 to 10^7 r (3 MeV X- an cathode rays) were measured optically. The crystal have advantages in measurements where wide range high absorption, small size and simplicity are desirable however, their use is restricted by the length of th bleaching period required between exposures.

537.542

517. A germanium counter. K. G. McKay. etter in *Phys. Rev.*, **76,** 1537–8 (*Nov.* 15, 1949).

The possibility of obtaining conductivity pulses hen α-particles bombard the contact of a phosphor-ronze point and Ge is considered. Experimentally, ulses are obtained with wide pulse height distribu-on but with well-defined max. height. Response mes are $< 0{\cdot}05$ μsec and space charge effects are ot significant. The counter is most sensitive to articles with high specific ionization.

G. F. J. GARLICK

537.542

518. The new technique of scintillation counters. II. M. Ageno, M. Chiozzotto and R. Querzoli. R.C. *Ist. Super. Sanità,* **12** (*Nos* 7–9) 577–85 (1949) *n Italian.*

Difficulty is encountered in the use of scintillation ounters for the study of cosmic radiation by the mallness of their sensible volume. The possibility is tudied of substituting for the fluorescent crystal a ransparent and fluorescent liquid. By means of a l.c. device utilizing a 931A photomultiplier, it is ound that whereas a large number of liquids are only lightly fluorescent to γ-rays of 2·62 MeV, there are olutions whose fluorescent power is not much nferior to that of a naphthalene crystal. Solutions of naphthalene in xylol, which have a medium luorescent power, do not comply with Perrin's aw. A.

537.542

2519. Noise in ionization chamber pulse amplifiers. R. Wilson. *Phil. Mag.*, **41,** 66–76 (*Jan.*, 1950).

The general problem of the detection of heavy onizing particles, in the presence of γ-radiation and background noise from the amplifier, is considered. It is shown that the max. possible signal/noise ratio is obtained if the input pulse is shaped to a form $\exp\{-|t-T_D|/\tau\}$. The signal/noise ratio is also calculated for other common pulse shapes. A practical amplifier circuit is discussed which may be used to detect 100 kV energy protons in the presence of intense γ-radiation. A.

537.542 : 621.318.572

2520. A simple scaler with adjustable scaling factor. D. Walker. Letter in *J. Sci. Instrum. Phys. Ind.*, **26,** 382 (*Nov.*, 1949).

A counting-down circuit of the "stairway" type is described. An 807 valve has in its anode circuit a capacitor connected across the anode and cathode of an S130 glow-discharge tube, the cathode being connected to the 807 anode. Successive pos. pulses applied to the 807 grid, which is otherwise cut off, cause the anode potential to fall in discrete jumps until the voltage across the capacitor is sufficient to fire the S130. The output is taken from the 807 anode. The scaling factor can be varied from 2 to 8 by adjustment of the 807 screen voltage. The top-pin anode of the valve, the direct connection from it to the tube cathode without use of a valve socket, and the high-quality capacitors chosen prevent leakage troubles so that satisfactory operation is obtained at a scale-of-4 with pulses at 8 sec intervals.

H. G. M. SPRATT (R)

537.542 : 621.318.572

2521. A stepping scale-of-ten counting unit. I. A. D. Lewis and J. F. Raffle. *J. Sci. Instrum.*, **27,** 7–27 (*Jan.*, 1950).

A scale-of-10 unit, employing 2 pentodes and 5 diodes, has been developed along the lines of the Miller integrating circuit. It is primarily designed for connection to the output of a commercial scale-of-100 unit to provide a scale-of-1 000 with meter indication of the number of hundreds. A number of such units, suitably modified, could be used in cascade to provide any desired scaling factor. Counting is achieved by the collection of discrete quantities of charge on a capacitor. A lower limit to the permissible counting rate, of about one count in 20 sec at the output, is imposed by leakage at the capacitor. The mechanical counter sets an upper limit of 9 counts/sec at the output; at this rate counting losses in the circuit are negligible. A.

537.542

2522. Note on analysis of delayed coincidence counting experiments. F. W. Van Name, Jr. Letter in *Phys. Rev.*, **76,** 1734 (*Dec.* 1, 1949).

Binder's conclusions [Abstr. 1811 (1950)] are not applicable to the author's results [Abstr. 2666 (1949)].

537.542 : 539.164

2523. A study of a Wilson's cloud chamber with large sensitive time and of its application in measuring range of α-particles emitted by Pu^{239}. H. P. De. *Indian J. Phys.*, **23,** 363–70 (*Aug.*, 1949).

A brief description of a cloud chamber with long sensitive time has been given. 3 different methods of determination of sensitive time have been described. The range of particles emitted from a specimen supposed to contain Pu^{239} has been determined. A.

IONIZATION . THERMIONICS 537.56/.58

537.56 : 537.591.8

2524. On the quantity of ionization caused by fast ionizing particles in proportional counters or ion chambers. M. I. Podgoretskiĭ. *Dokl. Akad. Nauk, SSSR,* **67** (*No.* 4) 631–3 (1949) *In Russian.*

The fluctuations caused by knock-on electrons from the walls of the counter are discussed. E. P. George

537.562

2525. A study of the specific coefficients of ionization. F. de la Ripelle. *J. Phys. Radium,* **10,** 319–29 (*Nov.*, 1949) *In French.*

In this treatment of electron-atom collisions, account is taken of the acceleration of the primary colliding electron by the atomic nucleus. The approximation is made, important in the classical theory of collisions, that at the instant of collision the interaction between an electron in the atom and the nucleus can be neglected in comparison with the interaction between that electron and the colliding electron. This simple method gives satisfactory results in treating atom aggregates; it has been applied to the ionization of the rare gases, H, and of Na vapour; and the (ionization probability—electron energy) curves calculated for single and for total ionization are in satisfactory

agreement with experimental data. The method is very successful in calculating the probability of extraction of the *K*-electrons of Ag for various energies of the primary electron.

F. LLEWELLYN JONES

537.563 : 539.164

2526. Relative yields of ions produced by α-particles in air and water vapour. R. K. APPLEYARD. Letter in *Nature, Lond.*, **164**, 838 (*Nov.* 12, 1949).

The relative ion yields at saturation were measured in a parallel plate chamber filled alternately (at 10–20 cm pressure) with water vapour (at 95°c) and air, and exposed to a beam of 5 MeV α-particles from Po. The energy expended per ion pair in water vapour was found to be $0{\cdot}878 \pm 0{\cdot}02$ of that in air. L. R. SHEPHERD

537.568

2527. Measurement of electron-ion recombination. M. A. BIONDI AND S. C. BROWN. *Phys. Rev.*, **76**, 1697–1700 (*Dec.* 1, 1949).

Microwave techniques are applied to the measurement of the recombination between electrons and positive ions. The measured recombination coeffs. for monatomic gases range from $1{\cdot}7 \times 10^{-8}$ cm³/ion-sec for He to 3×10^{-7} cm³/ion-sec for A. The recombination coeffs. for diatomic gases range from $2{\cdot}5 \times 10^{-6}$ cm³/ion-sec for H to $2{\cdot}8 \times 10^{-7}$ cm³/ion-sec for O. At electron temps. of 300°K, the recombination is found to be independent of pressure for the monatomic gases. A pressure-dependence is observed in diatomic gases, the recombination increasing with increasing pressure in N_2 and O_2. A.

537.581 : 548.57

2528. Thermionic work function of the (100) face of a tungsten single crystal. A. A. BROWN, L. J. NEELANDS AND H. E. FARNSWORTH. *J. Appl. Phys.*, **21**, 1-4 (*Jan.*, 1950).

A slab with one surface cut and etched parallel to (100) crystallographic planes formed the cathode in a low-power electron microscope. The electron image of the cathode was formed on a fluorescent screen with a small hole at the centre. An electron collector placed behind the hole permitted a measure of the electron current passing through the hole as a function of the temperature of the cathode as measured with an optical pyrometer. The most probable value of the work function, ϕ, obtained after 2 400 hours of outgassing in a sealed-off, gettered tube is $4{\cdot}59 \pm 0{\cdot}02$ eV. This may be compared with 4·56 eV obtained previously by Nichols for the work function in the [100] direction of a W single crystal wire. A.

537.581 : 621.385.032.216

2529. Thermionic emission from oxide cathodes: retarding and accelerating fields. C. S. HUNG. *J. Appl. Phys.*, **21**, 37–44 (*Jan.*, 1950).

An experimental investigation. The applied voltage range extends from the retarding potential region up to an average accelerating field of 50 kV/cm. The retarding potential range yields information on the energy distribution of the electrons emitted, and indicates an excellent agreement between theory and experiment for high retarding fields. Near zero field, cathode inhomogeneity or patch effect may be responsible for the deviations found. Consideration is given to the influence of a possible reflection effect but theoretical calculation indicates that with the large area cathode used, the simultaneous reflection at the emitter and the collector surfaces so alter the observed current/voltage relationship, that the existence or non-existence of a reflection effect cannot be determined by the experiment. Results shown in the accelerating field region up to 50 kV/cm are accounted for on two assumptions: (1) patch effect for small accelerating fields, (2) the intensification of the field at sharp points expected in view of the inherent roughness of the cathodes studied. The deviation of the experimental results from those predicted by the Schottky mirror-image theory is explained over the whole range of observation by these two assumptions. A.

COSMIC RAYS 537.591

537.59

2530. The density effect for cosmic-ray mesons. W. L. WHITTEMORE AND J. C. STREET. *Phys. Rev.*, **76**, 1786–91 (*Dec.* 15, 1949).

A detailed study of individual pulses produced by fast cosmic-ray mesons in a specimen of AgCl. A discussion is given of the pulse distributions obtained from the experiment, which was designed to show the increase with energy of the rate of ionization in the relativistic region and the correction to this increase due to the density effect. The measured values are compared with theoretical distributions which take fluctuation and density effect into account. It is concluded that the results agree well with the fluctuation theory developed by Symon and the density effect corrections as given by Halpern and Hall. A.

537.59

2531. Source of the cosmic rays. C. DARWIN. *Nature, Lond.*, **164**, 1112–14 (*Dec.* 31, 1949).

The validity of assuming thermodynamic equilibrium in the source is questioned. Several examples (e.g. cavitation phenomena) are instanced in which an amount of energy may be concentrated in a small part of a system, $\geqslant$ the equipartition value. The occurrence of similar phenomena at stellar surfaces is suggested as a possible source. The primary energy spectrum deduced is $\sim dE/E^2$. E. P. GEORGE

537.591 : 523.77

Cosmic radiation from the sun. *See Abstr.* 2138

537.591 : 537.54

On the photo-sensitivity of neon lamps and their use in cosmic-ray circuits. *See Abstr.* 2514

537.591 : 61

2532. Influence of cosmic radiation on induced carcinogenesis in mice. E. P. GEORGE, M. GEORGE, J. BOOTH AND E. S. HORNING. Letter in *Nature, Lond.*, **164**, 1044–5 (*Dec.* 17, 1949).

Attempts to repeat the experiments of Figge [Abstr. 2352 (1947)] in which cosmic radiation was alleged to effect the latent period of tumour development following injection, were unsuccessful.

E. P. GEORGE

537.591.1

2533. Measurements of the hard and soft components of cosmic rays using a circular arrangement of counters. S. A. AZIMOV. *Dokl. Akad. Nauk, SSSR*, **71** (*No.* 6) 1005–8 (1948) *In Russian.*

2-fold coincidences were recorded between a small central counter and a concentric ring of large counters. The hard component was determined by shielding with 10 cm Pb. Results are reported for heights of 200, 3 860 and 4 700 m. E. P. GEORGE

537.591.1

2534. On disintegrating particles in the composition of cosmic rays in the stratosphere. L. T. BARADZEĬ, S. N. VERNOV AND YU. A. SMORODIN. *Dokl. Akad. Nauk, SSSR*, **63** (*No.* 3) 233–4 (1948) *In Russian.*

A comparison is made of the counting rates of vertical and inclined telescopes at altitudes up to 15 km. The results are interpreted in terms of μ-meson decay. By displacing the extreme telescope counters, the contribution of showers was estimated, and with 8 cm Pb in the telescope, it was found that showers contribute $\sim 25\%$ of the coincidences at great height. E. P. GEORGE

537.591.1

2535. Definition of the sign of the charged primary particles of cosmic rays by measuring the azimuth asymmetry in the stratosphere in the equatorial region. S. N. VERNOV, N. L. GRIGOROV, N. A. DOBROTIN, E. P. SOKOLOV, F. D. SAVIN AND A. I. KURAKIN. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 2) 253–5 (1949) *In Russian.*

A counter telescope inclined at 60° to the vertical was maintained at heights up to 25 km. The E/W asymmetry was measured, with and without Pb absorbers in the telescope, and found to be $\sim 50\%$ at great height. E. P. GEORGE

537.591.1

2536. On the calculation of the moments of the distribution function of cascade particles. S. Z. BELENKIĬ. *J. Exp. Theor. Phys., USSR*, **19**, 940–5 (*Oct.*, 1949) *In Russian.*

Theoretical. Gives a recurrent formula for calculating all the moments of the distribution function. The method is illustrated by application to certain limiting cases. E. P. GEORGE

537.591.1

2537. Multiplicity in the hard component of cosmic radiation underground. E. P. GEORGE AND P. T. REN. Letter in *Nature, Lond.*, **164**, 838–9 (*Nov.* 12, 1949).

The simultaneous discharge of more than one counter in the bottom bank of a counter telescope containing 30 cm Pb was recorded, at a depth 60 m water equivalent. Multiple events associated with undischarged counters found situated between the extreme discharged ones are thought to be not due to knock-on showers. The suggestion that mesons can produce groups of penetrating particles (mesons?) is advanced. E. P. GEORGE

537.591.1

2538. Neutron production at mountain altitudes. W. G. MONTGOMERY AND A. R. TOBEY. *Phys. Rev.*, **76**, 1478–81 (*Nov.* 15, 1949).

The rate of production of neutrons by cosmic rays was measured at 3 510 m elevation in Pb, Al and paraffin, and in paraffin at 1 640 m elevation by means of an ionization chamber filled with BF_3. The variation with elevation for production in paraffin differs slightly from that in the heavier elements, but agrees well with observations by other observers of the production in air at higher altitudes and with the variation of extensive showers. The neutrons are produced with a larger multiplicity in Pb than in paraffin. Comparison with measurements of star production in photographic plates results in the value of 3 to 6 neutrons per star. Bursts of ionization resulting from other cosmic-ray phenomena were also observed. A.

537.591.1

2539. On the mass of charged particles of the cosmic radiation. C. FRANZINETTI. *Phil. Mag.*, **41**, 86–106 (*Jan.*, 1950).

The mass of charged particles, produced by cosmic radiation at an altitude of 11 000 ft, and brought to rest in photographic emulsions, has been determined by "magnetic-deflection" experiments. The method is applicable to particles, of any type, of which the lifetime is $> 10^{-10}$ sec. The results show that at an altitude of 11 000 ft the particles are composed of different types in the following proportions: μ^+-particles, $8{\cdot}5 \pm 1{\cdot}5\%$; μ^--particles, $8 \pm 2{\cdot}4\%$; π^+-particles, $4{\cdot}0 \pm 1{\cdot}0\%$; π^--particles, $5{\cdot}4 \pm 2{\cdot}0\%$; protons, $48 \pm 4\%$; deuterons, $16 \pm 2\%$; more massive positive particles, $11 \pm 2\%$. The observations on the tracks of 360 particles give no evidence for the existence of other kinds of particles sufficiently stable to be detected by this method; and they show that if such particles exist, they are very rare. A.

537.591.15

2540. Cosmic ray showers formed in thick layers of lead. L. N. KORABLEV, A. L. LYUBIMOV AND A. V. MILLER. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 4) 633–5 (1948) *In Russian.*

Penetrating showers were studied by means of 5 trays of counters in thick Pb shields, by using a hodoscope arrangement. A high density of particles in the showers was frequently observed, and the majority of the particles are held to be electrons. Such showers are called by the authors "special," and are known elsewhere as "mixed." By means of counters placed outside the absorbers, a correlation between mixed showers and extensive atmospheric showers was established, and the penetration of the shower particles through the side walls of the Pb absorbers studied. E. P. GEORGE

537.591.15

2541. The angular distribution of cosmic ray particles in the stratosphere. S. N. VERNOV AND A. M. KULIKOV. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 6) 1013–15 (1948) *In Russian.*

The angular dependence of 3-fold coincidences in a counter telescope was determined at various heights up to 30 km. It is concluded that the secondaries in the atmosphere maintain the direction of the primaries to within a few degrees. From the absence of E/W asymmetry at high altitude, it is deduced that the primary cosmic rays contain a significant proportion of negative particles. E. P. GEORGE

537.591.15

2542. A study of cosmic ray showers accompanying penetrating particles. K. I. ALEKSEEVA AND S. I. VERNOV. *Dokl. Akad. Nauk, SSSR*, **62** (*No.* 2) 199–202 (1948) *In Russian.*

A telescope containing 3 counters with 4 cm Pb absorbers, surrounded by 8 counters all in parallel, was lifted to 30 km by balloons. The frequencies C_3 of telescope coincidences and C_4 of telescope plus counter screen coincidences were radioed to ground. The proportion of showers defined by C_4/C_3 was found to vary from 6% at sea level to 40% at 30 km. The mean range of the primary particles was found to be ~ 100 g/cm^2.

E. P. GEORGE

537.591.15

2543. Cascade curves for lead. G. T. ZATSEPIN. *Dokl. Akad. Nauk, SSSR*, **63** (*No.* 3) 243–6 (1948) *In Russian.*

Theoretical. The cascade calculations have been carried out bearing in mind the variation of the pair-production cross-section, σ, with energy. It is found that cascade showers are significantly more penetrating in Pb than follows from the usual assumption $\sigma = \text{const}$. The absorption length well beyond the maximum is 0·26 cascade units. E. P. GEORGE

537.591.15

2544. Altitude-dependence and absorption curve in carbon of particles generating impulses in an ion chamber at 3 860 and 4 700 m. G. GURO, V. NIKOLAEV, L. RAZORENOV AND I. CHUVILO. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 4) 623–6 (1949) *In Russian.*

Bursts corresponding to $\geqslant 50$ relativistic particles through the chamber were recorded. Absorption lengths in air and C of 120 ± 30 and 310 ± 90 g/cm^2 respectively were obtained. The effect of absorber density on the correlation of particles is discussed. The exponent of the integral density spectrum was found to be $3{\cdot}3 \pm 0{\cdot}1$, both with and without a C absorber 192 g/cm^2 thick. E. P. GEORGE

537.591.15

2545. Some statistical correlations connected with observations of wide atmospheric showers. I. YA. BARIT AND M. I. PODGORETSKIĬ. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 1) 23–6 (1949) *In Russian.*

The fluctuations in particle density due to Rutherford scattering are evaluated, and their influence on the counting rate of a given system of counters considered. E. P. GEORGE

537.591.15

2546. A study of special showers of cosmic radiation with a hodoscope. L. N. KORABLEU, A. L. LYUBIMOV AND A. T. NEVRAEV. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 2) 273–6 (1949) *In Russian.*

7 trays of 22 counters each were packed closely under each other, with 3 mm Pb sheets between each tray. These counters were connected to Ne lamps in a hodoscope arrangement. The master-pulse was derived from a lower counter arrangement selecting penetrating showers. The whole 180 counters were surrounded by Pb 12 cm thick. Evidence was obtained for a large accompaniment of electrons and photons in penetrating showers and the development of these mixed showers in the thin Pb sheets was studied. Several examples of multiple shower cor with wide angular separations were recorded.

E. P. GEORG

537.591.

2547. The structure of cosmic ray air shower J. R. PRESCOTT AND C. B. O. MOHR. *Aust. J. Sci. Re A*, **2**, 184–97 (*June*, 1949).

The structure of cosmic-ray air showers at sea lev has been studied by an investigation of the burst ra frequency and the transition effect in Pb, for cosmi ray bursts occurring simultaneously in two hig pressure ionization chambers with varying separatio Although extensive showers were responsible for the coincidences observed with the larger chamb separations, they accounted for $< 3\%$ of the burs observed with a single chamber. Of the remainin 97%, somewhat more than $\frac{1}{2}$ appear to be due nuclear disintegrations and the rest either to narro showers of approximate radius 30 cm or to the co of an extensive shower of low density. The extensi shower frequency was about 10 times that predict by theory. The bearing of these results on prese views of the origin and development of air showers discussed.

537.591.

2548. Electron nuclear showers in cosmic rays an the nuclear cascade process. N. G. BIRGER, V. VEKSLER (WECHSLER), N. A. DOBROTIN, G. ZATSEPIN, L. V. KURNOSOVA, A. L. LYUBIMO I. L. ROZENTAL (ROSENTHAL) AND L. KH. EIDU *J. Exp. Theor. Phys., USSR*, **19**, 826–50 (*Sept.*, 194 *In Russian.*

Summarizes experimental work on mixed showe (called here "electronuclear showers," e.n.s.) pe formed 1945–48. Showers were recorded in counters under 10 cm Pb; they increase more rapid at altitude than the hard component. Contributio of knock-on showers were determined from observ tions below ground and subtracted from measur frequencies to give e.n.s. Range in air of e.n primaries ~ 120 g/cm^2 from observations up 20 km, in Pb ~ 500 g/cm^2, and in C ~ 450 g/cm E.n.s. were shown by hodoscopes to be of wide ang and high density, hence non-cascade. Clou chambers at 3 860 m show that showers under 20 c Pb contain electrons, penetrating particles and nucle fragments. Momentum spectra are reported usi cloud-chamber in field of 12 000 gauss. E.n.s. a closely connected with extensive showers; abo 25% of penetrating particles of extensive showe generate further e.n.s. Nuclear cascade processes a discussed in relation to e.n.s. and extensive shower

E. P. GEORG

537.591.

2549. Wide angle sprays of minimum ionizati particles. F. OPPENHEIMER AND E. P. NEY. Letter *Phys. Rev.*, **76**, 1418–19 (*Nov.* 1, 1949).

A cloud chamber containing 5 $\frac{1}{4}$-in Pb plates h been operated for 3 hr at residual pressure 14 g/cm (balloon flight). Characteristic events are wide-ang sprays of soft minimum ionization particles which not necessarily project back to a single point. Abo $\frac{1}{3}$ of sprays are accompanied by heavily ioniz particles, while about $\frac{1}{3}$ contain at least one parti which penetrates $\frac{1}{4}$ in Pb. The sprays are unlikely

be due to the tail of large cascades in which the shower axis does not traverse the chamber. J. G. WILSON

537.591.15

2550. The analysis of bursts of cosmic-ray ionization. C. G. MONTGOMERY AND D. D. MONTGOMERY. *Phys. Rev.*, **76**, 1482–8 (*Nov.* 15, 1949).

The agents responsible for the production of bursts of ionization in small chambers have been analysed on the basis of observations taken at 3 510 m elevation. 3 methods of separation were employed: (1) the coincidences between ion chambers and between chambers and counters, (2) the variation of burst rate with a small thickness of Pb placed over the chamber, and (3) the variation of burst rate with the size of the ionization chamber. 3 components of the burst distribution curve are identified with (1) small locally produced electron showers, (2) nuclear disintegrations, and (3) extensive air showers of high density. Each component predominates at a certain range of burst sizes. A.

537.591.15

2551. Narrow air showers of cosmic rays. J. WEI AND C. G. MONTGOMERY. *Phys. Rev.*, **76**, 1488–93 (*Nov.* 15, 1949).

Observations are reported of the decoherence curves for air showers of cosmic rays at sea level, 1 640 m and 3 510 m elevation. The variation of the decoherence curves with counter area and the absorption of narrow showers were also measured at the highest elevation. It was found that narrow showers (i.e. showers observed at small counter separations) differ from ordinary extensive air showers with respect to variation with elevation, variation with area of the counters and penetrating power. Consideration of the effects of pressure on the spreading function show that the altitude variation cannot be taken as a certain indication that narrow showers differ in nature from extensive ones, nor can the variation with counter area. The relative penetration, however, of narrow showers in Pb, Fe and Al cannot be explained except by differences in the nature of the particles involved. A.

537.591.15

2552. Comparison of calculations on cascade theory. H. S. SNYDER. *Phys. Rev.*, **76**, 1563–71 (*Dec.* 1, 1949).

The diffusion equations of the cascade theory of electron showers are solved using improved mathematical methods. The results obtained agree essentially with those obtained earlier by Carlson and Oppenheimer, by Snyder and by Serber, but do not agree with those obtained by Bhabha and Chakrabarty. Solutions are given corresponding to a single incident electron, a single incident γ-ray and a $1/E$ spectrum of γ-rays. The total number of particles expected under a given thickness of material are given in tables for various incident energies and each of the above initial conditions. Other tables and formulae are included which enable one to calculate the spectrum of the particles and γ-rays for various initial conditions. A.

537.591.5

2553. Horizontal component of cosmic radiation at sea level. I. M. FRANK AND I. C. SHAPIRO. *Dokl. Akad. Nauk, SSSR*, **61** (*No.* 5) 825–8 (1948) *In Russian.*

This was studied using a cloud chamber containing vertical plates. A table of results and 2 pictures are presented. Several possible explanations are discussed. E. P. GEORGE

537.591.5

2554. Altitude-dependence of heavy particles caused by cosmic rays. G. E. BELOVITSKIĬ AND L. V. SUKHOV. *Dokl. Akad. Nauk, SSSR*, **62** (*No.* 2) 207–10 (1948) *In Russian.*

The number of tracks per cm² per day is given for nuclear emulsions exposed at heights from 200 to 6 000 m. The variation with height corresponds to an exponential absorption with $L_A = 160 \pm 30$ g/cm². At 3 860 m, the frequency of tracks is given as $2{\cdot}6 \times 10^{-2}$/cm²/min. The track distribution was found to be isotropic at all heights. E. P. GEORGE

537.591.5

2555. On the empirical angular distribution of the penetrating component in the lower atmosphere. A. FRÉON AND TSAI-CHU. *C.R. Acad. Sci., Paris*, **229**, 753–5 (*Oct.* 17, 1949) *In French.*

The angular distribution was measured at different altitudes and with various absorbers in the telescope. Expressing the dependence on θ as $\propto \cos^n \theta$, an empirical formula is given for n as a function of altitude and meson energy. E. P. GEORGE

537.591.5 : 523.72

2556. Intense solar emission of cosmic rays. A. DAUVILLIER. *C.R. Acad. Sci., Paris*, **229**, 1096–8 (*Nov.* 28, 1949) *In French.*

An increase of cosmic-ray intensity of 3·6% measured in an unshielded ionization chamber at 550 m altitude is discussed and correlated with a solar eruption. J. G. WILSON

537.591.8

2557. The production of high energy electrons and photons in the depths of the atmosphere by cosmic rays. G. YA. ARTYUKHOV, G. T. ZATSEPIN, L. I. SARYCHEVA AND L. KH. EIDUS. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 3) 465–8 (1949) *In Russian.*

The variation of the frequency of soft showers in the atmosphere is corrected for the effects of air pressure on the efficiency of recording them. The soft component is then found to follow closely the nuclear component (hard showers, etc.) and equilibrium is postulated. The non-cascade origin of a fraction of the soft component in the lower atmosphere is discussed. Transition curves for dense showers in Pb associated with extensive showers at heights up to 4 700 m are presented. E. P. GEORGE

537.591.8

2558. On the existence of light varitrons. A. I. ALIKHANYAN, A. A. KONSTANTINOV, V. M. KHARITONOV AND M. I. DAION. *J. Exp. Theor. Phys., USSR*, **19**, 857–67 (*Oct.*, 1949) *In Russian.*

The counter system of the mass-spectrograph was modified in order to record larger magnetic deflections and hence smaller momenta. The momentum spectrum was investigated at intervals in the range 30 to 80 MeV/c. In this region of momentum, the authors conclude that particles exist in cosmic rays whose masses are 50, 80, 100 and 150 m_e. E. P. GEORGE

537.591.8

2559. An investigation of the spectrum of the masses of varitrons. I. A. Alikhanyan, V. Morozov, A. Khrimyan, G. Muskhelishvili and V. Kamalyan. *J. Exp. Theor. Phys., USSR*, **19**, 1021–56 (*Nov.*, 1949) *In Russian.*

Improvements in the magnetic mass-spectrograph have been carried out which are alleged to enable more accurate mass values of varitrons to be obtained. Low efficiency counters were introduced to indicate the specific ionization of particles. The momentum spectrum of the particles in air was found to have a sharp maximum at low values, followed by a plateau. The small width of the maximum is taken to indicate that some varitrons have a short life, $< 10^{-6}$ sec. A positive excess in the particles at 3 250 m was found, about 13% of all particles being fast protons. In air a very large excess of positive varitrons, much heavier than protons, was recorded. Mass values given are: 300 ± 10; 380 ± 20; 450 ± 20; (650); 730 ± 20; 970 ± 30; $1\,300 \pm 70\ m_e$, and several values from $2\,500 \pm 200$; to $\sim 12\,000\ m_e$.

E. P. GEORGE

537.591.8

2560. On the nuclear evaporation in cosmic rays and the absorption of the nucleonic component. I. G. Bernardini, G. Cortini and A. Manfredini. *Phys. Rev.*, **76**, 1792–7 (*Dec.* 15, 1949).

The absorption of the star-producing radiation was studied with the sensitive emulsion method. The results are connected with the behaviour of the nucleonic component, as is indicated by some recent experimental data. A.

537.591.8 : 537.56

Quantity of ionization caused by fast particles in counters and ion chambers. *See Abstr.* 2524

MAGNETISM 538

538.082.74 : 621.317.44

2561. A measuring generator for magnetic fields. W. Ploch. *Z. angew. Phys.*, **1** (*No.* 11) 525–6 (1949) *In German.*

A hollow, non-magnetic spindle, 45 cm long, carries a "measuring" coil (350 turns, 30 mm²) at one end, and a "reference" coil (300 turns, 80 mm²) at the other. The spindle is spun at 6 000 r.p.m. by a small motor mounted near the reference coil. The measuring coil spins in the field under test, and the reference coil in a diametrically disposed field provided by a permanent magnet which can be turned concentrically with the spindle. The two coils are connected through 3 slip-rings to two high resistances (10^4–$10^6\ \Omega$), the combination forming a bridge network. An amplifier ($A = 6\,000$) and c.r.o. function as balance detector. In use, the bridge is balanced for both voltage and phase by adjusting the resistances and angular position of the reference field magnet. The latter (readable to 1°) gives the test field direction, and the former the ratio B (test field)/B (reference field), both measurements being the components perp. to the axis of rotation. The sensitivity is given as 0·5 gauss 50%, 50 gauss 1% > 50 gauss at least 0·25%. C. F. PIZZEY

538.11

2562. A modified perturbation procedure for problem in paramagnetism. M. H. L. Pryce. *Proc. Phys. Soc. Lond. A*, **63**, 25–9 (*Jan.*, 1950).

A technique is described for problems in which second-order effects are comparable in magnitude with first-order effects, where orthodox methods break down. It is applied to the energy levels of paramagnetic ions in a crystal, giving an effective Hamiltonian in which the Stark splitting, the anomalous g-value and the temp.-independent paramagnetism are clearly exhibited. A.

538.114

2563. Physical theory of ferromagnetic domains. C. Kittel. *Rev. Mod. Phys.*, **21**, 541–83 (*Oct.*, 1949).

A comprehensive review of the physical principles of domain theory and of the crucial experiments which bear directly on the foundations of the subject. An introductory survey which describes the basic physical concepts of domain theory in general non-mathematical terms is followed by sections in which the ideas are developed in detail. Quantitative expressions are derived for the several types of energy which enter into the theory of domain structure and for the energy of Bloch walls. The effect of these contributions to the energy is considered in relation to crystal shape and theoretical domain configurations are deduced. A short account is given of the results of work on magnetic powder patterns. The magnetic properties of small particles, particularly coercive force, are discussed and also the initial permeability and coercive force of magnetic materials generally.

A. E. De Barr

538.114

2564. Mechanism of coercive force and remanent magnetism of MnBi powder, and its generalization. C. Guillaud. *C.R. Acad. Sci., Paris*, **229**, 992–3 (*Nov.* 14, 1949) *In French.*

The high coercive force of MnBi powder is attributed to the behaviour of grains consisting of single domains, in which reversal of magnetization occurs by rotations and not by boundary displacements. It is shown that for such grains the remanent magnetism approximates to the spontaneous magnetization and the coercive force approaches a limiting value dependent on the magnetocrystalline energy, and the possibility is suggested of constructing magnets of finely divided ferromagnetic materials in which the axes of easy magnetization of the grains are parallel. C. E. WEBB

538.114

2565. Theory of the formation of powder patterns on ferromagnetic crystals. C. Kittel. Letter in *Phys. Rev.*, **76**, 1527 (*Nov.* 15, 1949).

Discusses the mechanism of the collection of particles at domain boundaries to form Bitter patterns. The distribution law is deduced from the energy of a particle in a magnetic field and Boltzmann's law, both for colloidal particles and for particles small enough to behave as single domains. The condition for the appearance of a line in the absence of an external field is derived, and the effect of applying a uniform external field is shown. C. E. WEBB

538.12 : 537.533.72 : 621.385.833

2566. Electron optical mapping of electromagnetic fields. L. MARTON AND S. H. LACHENBRUCH. *J. Appl. Phys.*, **20**, 1171–82 (*Dec.*, 1949).

Two techniques have been devised for the exploration of electrostatic and magnetic fields where conventional methods fail. Both use electron lens systems to magnify the deflecting effect of the fields on electron beams. One technique is the electron optical analogue of the "Schlieren" method; the other involves deformed shadows of a thin obstruction. For several reasons the "Schlieren" patterns obtained experimentally thus far have been interpreted only qualitatively. The patterns obtained by the shadow method, however, have been used for quantitative evaluation of field strengths. Experimental patterns of both types, produced by the fields of magnetized recording wires, are shown. The shadow method is theoretically applicable to the quantitative evaluation of a wide variety of electric and magnetic fields. It utilizes formulae based on relations between field distribution and electron deflection, and between the latter and the geometrical parameters of a focusing system. Such formulae are derived and applied to several simple types of field. An application of the theory to the magnetized wires used in the experiments yields relations from which each field distribution is evaluated by fitting a line to experimentally determined points. The theory also predicts the geometrical properties of the experimental patterns. The agreement between theory and experiment justifies the underlying theoretical assumptions and approximations. A.

538.221

2567. Magnetic properties of nickel-cobalt and related alloys. E. P. WOHLFARTH. *Phil. Mag.*, **40**, 1095–1111 (*Nov.*, 1949).

Experimental data for Ni–Co and Ni–Fe alloys, shown in a number of figures, includes (1) variation of the saturation moment, σ_0, and the Curie temp., θ, with concentration, c, and of the susceptibility and spontaneous magnetization with temp. Values of θ derived theoretically agree well with observed values. The discrepancies are ascribed to deviations in the energy band shape from that presupposed. The character of the variation of the magnetization/temp. curves is considered. The results for Ni–Cu suggest that the interchange interaction energy varies as the square of the relative magnetization, ζ, so long as ζ^2 is $<$ about 0·9. Results for other alloys are also shown. For Ni–Cr and related alloys the variation of the magnetic properties with concentration is apparently due to a filling-up of the holes in the d-band of Ni by some, or all, of the outermost electrons of the added element, as in Ni–Cu.

L. S. GODDARD

538.221 : 537.533.72

2568. Fringe fields of ferromagnetic domains. L. MARTON, S. H. LACHENBRUCH, J. A. SIMPSON AND A. VAN BRONKHURST. *J. Appl. Phys.*, **20**, 1258 (*Dec.*, 1949).

538.221 : 538.662.15

2569. Ferromagnetic properties of a Co single crystal. C. GUILLAUD AND M. ROUX. *C.R. Acad. Sci., Paris*, **229**, 1062–4 (*Nov.* 21, 1949) *In French.*

Records precise measurements of the variation of magnetization parallel to the easy axis with H and temp., and of the magnetocrystalline energy at 20° and −196°C. The saturation magnetization at 0°K computed for pure Co is $\sigma_{0,\infty} = 160{\cdot}87$ equivalent to a Bohr magneton number of 1·70.

C. E. WEBB

538.222

2570. The principal magnetic susceptibilities of single crystals of rare earth salts at low temperatures. II. Praseodymium salts. A. MOOKHERJI. *Indian J. Phys.*, **23**, 309–20 (*July*, 1949).

The principal susceptibilities of Pr salts have been measured from room temp. down to liquid air temp. The results are discussed in terms of the crystalline electric field theory. It is found that (1) on the basis of a single suitable cubic field the observed magnetic moment at all temps. in the range studied can be explained satisfactorily; (2) the observed large anisotropies of the crystals point to the existence of strongly asymmetric rhombic field; (3) a rough estimate of the rhombic part of the field shows that the splitting by it is by no means small and compares favourably with the cubic splitting; (4) the χ_1-axis of Pr sulphate rotates by about 63° in the range studied. A.

538.222

2571. Abnormal magnetic properties of V_2O_3 between 60°C and 250°C. G. FOËX AND J. WUCHER. *C.R. Acad. Sci., Paris*, **229**, 882–4 (*Nov.* 2, 1949) *In French.*

The paramagnetic susceptibility of V_2O_3 is independent of temp. between 110°C and 250°C. At lower and higher temps. it obeys Weiss's law, the constants in the two ranges being slightly different. A short transition region occurs between each of these ranges and the constant-susceptibility range, there being no discontinuity in the variation of susceptibility with temp. C. E. WEBB

538.222

2572. Magnetic resonance absorption of diluted iron ammonium alum. R. T. WEIDNER, P. R. WEISS, C. A. WHITMER AND D. R. BLOSSER. Letter in *Phys. Rev.*, **76**, 1727–8 (*Dec.* 1, 1949).

Paramagnetic absorption spectra have been measured at 9 375 Mc/s at room temps., using single crystals in which some of the Fe ions are replaced by Al. Absorption curves for different dilutions are given for orientations of the d.c. field perp. to the crystalline faces (100), (111) and (110). A partial resolution of the individual lines has been obtained.

G. F. HODSMAN

538.222

2573. The paramagnetic resonance from nickel fluosilicate. R. P. PENROSE AND K. W. H. STEVENS. *Proc. Phys. Soc. Lond. A*, **63**, 29–36 (*Jan.*, 1950).

The resonance from the Ni ion has been investigated at a number of frequencies and temps. It has previously been suggested that the ion is in an electric field of trigonal symmetry. The results obtained are in good agreement with this hypothesis. It is also found that the magnitude of the splitting of the levels varies with temp. A.

538.222

2574. The theory of magnetic resonance-line widths in crystals. M. H. L. Pryce and K. W. H. Stevens. *Proc. Phys. Soc. Lond. A*, **63**, 36–51 (*Jan.*, 1950).

A theory is developed for calculating the mean displacements and mean square widths of resonant absorption lines in crystals for which the spin-lattice relaxation time is long compared with the spin-spin relaxation time. The theory is applied to a number of different cases; in particular, the effects of nuclear hyperfine structures and exchange forces in ionic resonances are discussed at length. It is shown that the theory holds, provided that the temp. is high compared with the Curie temp. A.

538.24

2575. Remarks on the kinetics of the magnetization of a classical electron gas. I. Z. Fisher. *J. Exp. Theor. Phys., USSR*, **19**, 937–9 (*Oct.*, 1949) *In Russian.*

According to Terletski–van Leewen's theorem, the magnetization of the classical electron gas in the state of statistical equilibrium is zero. This refers only to equilibrium, so that e.g. in an alternating field magnetization will occur. The attempt to calculate this effect without allowing for relaxation properties of the system must yield incorrect results [see, e.g., Abstr. 2487 (1949)]. However, the problem can be solved by the general methods of statistical mechanics. It reduces to a boundary value problem of the non-equilibrium distribution function in the phase space $n(\bar{r},\bar{p};t)$ satisfying the corresponding kinetic equation. It follows that the magnetic moment must depend greatly on the shape of the space occupied by the system and on its particular relaxation properties. This is brought out by the calculation of the distribution function and magnetic moment. B. F. KRAUS

538.244 : 537.312.62

2576. The magnetization of superconducting plates in transverse magnetic fields. E. R. Andrew and J. M. Lock. *Proc. Phys. Soc. Lond. A*, **63**, 13–25 (*Jan.*, 1950).

The magnetization curves of thin superconducting Sn plates were measured in transverse magnetic fields in order to investigate the nature of the intermediate state in such specimens. The curves showed peak magnetizations $\geqslant H_c/4\pi$, indicating the presence of fields $\geqslant$ the critical field at the edge of the plates. This effect is qualitatively similar to that predicted by Landau's theory of the intermediate state, but quantitative agreement is not obtained. Resistance measurements on thin strips of Sn in transverse fields showed that resistance only reappears for fields considerably $>$ those required to start the destruction of superconductivity. A.

538.244.2 : 621.318.33

2577. A simply-constructed small electromagnet of high performance. R. P. Hudson. *J. Sci. Instrum. Phys. Ind.*, **26**, 401–3 (*Dec.*, 1949).

A Weiss-type electromagnet is described which will produce fields of 20 kgauss in a pole-gap of 3–5 cm. It is mounted on a trolley base for manœuvrability. The coils, which are designed to dissipate 100 kW, are layer-wound from enamelled Cu strip and encased in insulating material. Cooling is provided by circulating distilled water through a simple heat exchanger which is cooled by main water. The coil cases are made water-tight by means of rubber seals and may be easily dismantled for inspection. A.

538.245

2578. Unsymmetrical hysteresis loops in a nickel-iron alloy. J. L. Rothery and A. Wang. Letter in *Nature, Lond.*, **164**, 1004–5 (*Dec.* 10, 1949).

In certain grain-oriented Ni–Fe alloys a.c. hysteresis loops obtained after the momentary application of a large d.c. magnetizing force possess an asymmetry which persists after disconnection for weeks or after cyclic magnetization to saturation. A core of these materials can thus store information of the polarity of the last magnetizing pulse. C. E. Webb

538.245

2579. Magnetization curves of ferromagnetic single crystals. H. Lawton. *Rep. Brit. Elect. Res, Assn (Ref. No. N/T46)* 1–15 (1949).

In a previous report [Abstr. 3331 (1949)] an explanation was provided of the process of magnetization of a single crystal where the field was applied in a (100) plane of the crystal. The present report deals with the case of oblate spheroids of Fe and FeSi where the equatorial plane is (110) and the magnetic field is applied in this plane. A.

538.245

2580. Theory of hysteresis loops. N. A. Akulov, O. S. Galkina and V. I. Ivanovskiĭ. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 5) 833–6 (1949) *In Russian.*

Starting from the classical Rayleigh–Stoletov theory, the author derives an important relation between hysteresis losses and residual magnetization: $Q_h = 8I_rH_m/3$. The residual magnetization is given by $I_r = \frac{1}{2}bH_m^2 + \frac{1}{3}cH_m^3$. The experimental investigation was carried out on Fe–Co specimens on an Akulov–Bozorth magnetometer. Excellent agreement with theory was obtained. B. F. KRAUS

538.245

2581. Temperature-dependence of the coercive force of highly coercive alloys. N. V. Bulgakov. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 5) 627–8 (1949) *In Russian.*

The alloys investigated were alni, alnico and magnico, of each of which 3 specimens were subjected to different heat treatments. They were investigated in the reversibility range of magnetic phenomena. The linear character of the variation of the coercive force was found in all cases. For non-tempered magnico the sense of variation of the coercive force is opposed to that of the others.

B. F. KRAUS

538.245 : 539.374

2582. Influence of plastic deformations on the temperature relation of the coercive forces. Ya. S. Schur and K. B. Vlasov. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 5) 647–50 (1949) *In Russian.*

Influence of the cold hardening of Fe, dynamo and transformer steel, and Mo permalloy on the temp.-dependence of the coercive force was investigated. The experimental curves show that there is a critical value of the deformation beyond which the relative values of the coercive force at temps. $>$ room temp. decrease. The heat treated transformer steel has a relative min. at about 380°. Ni is particularly sensi-

de to deformation and to the temps. to which it is ated. B. F. KRAUS

538.248

83. Variation of thermoremanent and isothermal manent magnetizations of baked clays with applied ld. J. ROQUET. *C.R. Acad. Sci., Paris,* **229,** 35–7 (*Nov.* 28, 1949) *In French.*

Records measurements on a baked clay sample of) thermoremanent magnetism after cooling from e Curie point in fields up to 7 700 oersted, (2) isothermal remanent magnetism after magnetization in elds up to 25 000 oersted. (1) increases with *H* uch more rapidly than (2) in weak fields, but both pear to be approaching the same saturation value, uggesting a common mechanism of the two effects.

C. E. WEBB

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

584. The linearity of Maxwell's equations. P. KUNZE. *Naturwissenschaften,* **36,** 356–9 (*No.* 12) 1949) *In German.*

Born's theory of the field near an electron, and Euler's theory of the scattering of light by light nay both be described as implying a failure of the inear equations of electrodynamics. The two heories, and some associated experiments, are riefly described. P. M. DAVIDSON

538.314

2585. Electrodynamics in a rotating frame of eference. M. G. TROCHERIS. *Phil. Mag.,* **40,** 1143–54 (*Nov.*, 1949).

The laws of electrodynamics in a rotating system modification of Maxwell's laws) are formulated after an analysis of the transformation between 2 systems of Cartesian co-ordinates, in uniform relative motion about their common *z*-axis. These are applied to various problems: (1) the field of a rotating spherical condenser, (2) the field of a rotating current, (3) the field of a rotating cylindrical magnet. L. S. GODDARD

538.522.22 : 621.3.011.3

2586. The stability of inductance standards. G. H. RAYNER AND L. H. FORD. *J. Sci. Instrum.,* **27,** 19–21 (*Jan.*, 1950).

Information about the stability of inductance standards acquired at the N.P.L. during the last 30 years is reviewed, and it is shown that the present working standard of mutual inductance, which is of the oil-immersed type and was constructed in 1937, has remained constant within ± 2 parts in 100 000 throughout its use. The stability of the primary standard is considerably better, but some standards of the ordinary construction have changed by a few parts in 10 000 in a few years. Data are also given for standards of self-inductance. A.

538.56 : 535.214

2587. Torque and angular momentum of centimetre electromagnetic waves. N. CARRARA. Letter in *Nature, Lond.*, **164,** 882–4 (*Nov.* 19, 1949).

When an e.m. wave, with a specified type of polarization, is normally incident on a device which either absorbs the wave or produces a reflected and a transmitted wave with specified types of polarization, the torque acting on the device may be calculated by the classical theory. It is here noted that the same formulae may be obtained by using the photon theory, and experiments are described, with waves of length 3·2 cm, giving an approximate test of the theory. P. M. DAVIDSON

538.56 : 535.43

2588. The scattering cross section of spheres for electromagnetic waves. L. BRILLOUIN. *J. Appl. Phys.*, **20,** 1108–25 (*Nov.*, 1949).

The computation of the scattering cross-section, according to classical theory, leads to difficulties. In the case of large spheres, where geometrical optics should apply, the rigorous theory yields a scattering cross-section $= 2\times$ the actual cross-section of the sphere. The discussion presented explains this result and shows the role played by the shadow and by the diffraction fringes surrounding the shadow. A reasonable system of approximations yields the well-known "Babinet's principle." The physical interpretation is of such general character that it must certainly apply to a variety of similar problems in acoustics or wave mechanics. The spherical shape of the obstacle is essential in the present discussion, but similar results would certainly be found for other shapes of the obstacle. The case of a circular cylinder also leads to a total cross-section twice as large as the actual cross-section, for large cylinders. The explanation is the same as for the spheres. Experiments gave a very precise check of the theoretical predictions. A.

538.561 : 621.385.833

2589. Increasing space-charge waves. J. R. PIERCE. *J. Appl. Phys.*, **20,** 1060–6 (*Nov.*, 1949).

An earlier paper [Abstr. 2133 (1948)] presented equations for increasing waves in the presence of two streams of charged particles having different velocities, and solved the equations assuming the velocity of one group of particles to be zero or small. Numerical solutions giving the rate of increase and the phase velocity of the increasing wave for a wide range of parameters, covering cases of ion oscillation and double-stream amplification, are presented here. A.

538.563 : 537.525

2590. The spherical electromagnetic proper oscillations of spaces which contain plasma. W. O. SCHUMANN. *Z. Naturforsch.*, **4a,** 486–91 (*Oct.*, 1949) *In German.*

For the cases of a spherical enclosure filled with plasma, of a dielectric and a conducting sphere in an atmosphere of plasma, and of a sphere of plasma in air, this paper examines the effect of the frequency-dependent permittivity on the oscillations, and the extent to which the possibility of a negative permittivity makes new types of oscillation possible.

P. M. DAVIDSON

538.566

2591. General expression of Huyghens' principle for electromagnetic waves in an imperfectly transparent medium. J. BRODIN. *C.R. Acad. Sci., Paris,* **229,** 1064–6 (*Nov.* 21, 1949) *In French.*

It is shown that, in the region outside a given

surface, an electromagnetic field (satisfying certain conditions at infinity) may be regarded as due to a sheet of electric dipoles and a sheet of magnetic dipoles in the surface, one of the two sheets being arbitrary. P. M. DAVIDSON

538.566

2592. The Green's function of electromagnetic waves in a half-space with a plane discontinuity. T. KAHAN AND G. ECKART. *J. Phys. Radium*, **10**, 333–41 (*Nov.*, 1949) *In French.*

Formulae are found for the field due to a Fitzgerald dipole in a medium bounded by an infinite plane conductor, the dielectric constant of the medium having a uniform value up to a plane at a certain distance from the conductor, and there changing discontinuously to another uniform value. P. M. DAVIDSON

538.566 : 621.396.11

2593. Measurements of the reflection coefficient of water at a wavelength of 8·7 mm. D. G. KIELY. *Proc. Phys. Soc. Lond. B*, **63**, 46–8 (*Jan.*, 1950).

The method employed is to measure the relative field strengths of the direct waves and waves reflected from a trough of water using free-space propagation and high-gain aerials. The following electrical constants of water have been computed from the measured results (water temp. 11·1°c): refractive index $4{\cdot}40 \pm 0{\cdot}24$, dielectric constant $10{\cdot}86 \pm 2{\cdot}21$, absorption coeff. $2{\cdot}91 \pm 0{\cdot}06$, conductivity/frequency $12{\cdot}82 \pm 0{\cdot}42$, Brewster angle 79°. A.

538.566 : 534.232

2594. A new method of solving the problem of a point source of radiation in a stratified-inhomogeneous medium. L. M. BREKHOVSKIKH. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13** (*No.* 4) 409–20 (1949) *In Russian.*

The theory is developed in parallel for the acoustical and electromagnetic case and does not use the wave equation which in this case leads to insurmountable difficulties, but from Hertz's vector of an elementary dipole. The basic difficulty of the investigation consists in the fact that the medium and the wave possess different symmetries. This can be overcome, however, by resolving the spherical wave into plane waves and analysing the behaviour of the individual plane waves. A close analogy between the problem considered and diffraction phenomena is then observed, and the method followed in the latter case also proves its value here. There is no objection to resolving the original wave into wavelets having the same symmetry character as the object on which they are diffracted, or, in the case considered here, as the stratified medium. The method yields the discrete spectrum, lateral waves and other characteristics of this particular case. B. F. KRAUS

538.566 : 535.42 : 621.396.11

2595. On the diffraction of radar waves by a semi-infinite conducting screen. C. W. HORTON AND R. B. WATSON. *J. Appl. Phys.*, **21**, 16–21 (*Jan.*, 1950).

The diffraction patterns of radar waves about a semi-infinite copper screen have been measured. The measurements were made by revolving a bisectoral horn in a circle of radius 15 or 30 in about the diffracting edge. Measurements were made at three positions along the edge, one of which coincided with the corner of the screen, so that the pattern obtained was actually that of a quarter-infinite plane. Measurements were made for two orientations of the screen corresponding to angles of incidence of 0° and $-22\frac{1}{2}°$. Theoretical patterns have been calculated for the entire 360° of rotation and these agree well with the experimental patterns. A comparison is made between the theory, measurements and the equivalent optical measurements. A

538.566.2

2596. Measurement of the complex conductivity of an ionized gas at microwave frequencies. F. P. ADLER. *J. Appl. Phys.*, **20**, 1125–9 (*Nov.*, 1949).

The positive column of a glow discharge is placed along the axis of a cylindrical cavity excited in the TM_{010} mode. The transmission of 3 cm waves through the cavity and the shift in resonant frequency are observed as a function of discharge current. It is shown that from these measurements values of the complex conductivity, $\sigma_r + i\sigma_i$, of the electron gas can be calculated. Curves of the measured conductivity components as functions of pressure and current are given. Using a theoretical formula for the conductivity values of electron density can in turn be calculated from both σ_r and σ_i. Langmuir probe studies are carried out to check the results obtained, and adequate agreement is found. A.J.

538.566.2

2597. Propagation of electromagnetic waves in ferromagnetic materials. H. ARZELIÈS. *C.R. Acad. Sci., Paris*, **229**, 1218–20 (*Dec.* 5, 1949) *In French.*

In the equations of a damped sinusoidal wave travelling in a ferromagnetic medium, and represented by complex vectors, not only the dielectric constant, but also the magnetic permeability must, throughout a considerable range of frequency, be regarded as a complex quantity. Formulae for the reflection and refraction at the interface between two media are derived. P. M. DAVIDSON

538.566.2 : 534.24

Reflection of plane waves from inhomogeneous layered media. *See Abstr.* 2274

538.566.2 : 621.396.11.029.6

2598. The measurement of the velocity of propagation of centimetre radio waves as a function of height above the earth. II. The measurement of the velocity of propagation over a path between ground and aircraft at 10 000, 20 000 and 30 000 ft. F. E. JONES AND E. C. CORNFORD. *Proc. Instn Elect. Engrs, Pt III*, **96**, 447–52 (*Sept.*, 1949).

For Pt I see Abstr. 169 B (1948). The results are given of experimental flights observed from two Oboe ground stations in order to measure the velocity of propagation as a function of height above the earth. The results indicate higher velocities than those previously calculated. The most probable values for the mean velocity of propagation between ground and aircraft at 10 000, 20 000 and 30 000 ft are 299 713, 299 733 and 299 750 km/sec respectively. A.

538.566.3

2599. Calculation of the absorption coefficients for a parabolic ionospheric layer in the case of normal incidence. E. ARGENCE AND K. RAWER. *C.R. Acad. Sci., Paris*, **229**, 996–7 (*Nov.* 15, 1949) *In French.*

A short mathematical note on expressions which arise in this case. W. J. G. BEYNON

538.566.3 : 621.396.11

)0. The wave equations for electromagnetic radia-n in an ionized medium in a magnetic field. K. C. STFOLD. *Aust. J. Sci. Res. A*, **2**, 169–83 (*June*, 9).

The inadequacy of the present practice of applying formulae of magneto-ionic theory to ray tra-tories satisfying Snell's law, to represent the nditions of propagation of radio waves in the iono-here and the solar atmosphere, is explained. To press the differential equations of the electro-gnetic field as simply as possible the axes of co-dinates are chosen to coincide with the 3 principal rections of the medium. Wave equations for the mponents of the electric field intensity and the ctric Hertz vector are investigated. In applying e theory to the propagation of plane waves in a iform medium, a new fundamental form of the uation for the complex refractive index of the pleton–Hartree theory is obtained. The 3 types electron plasma oscillations possible in such a edium are also discussed. It is suggested that solar ursts" should decay according to a damping nstant of the order of the collision frequency when ey originate in the solar atmospehre. A.

538.566.3 : 621.396.11

501. Radio wave trajectories in the ionosphere. Theoretical principles. H. POEVERLEIN. *Z. angew. hys.*, **1** (*No.* 11) 517–24 (1949) *In German.*

Continuation of an earlier paper [H. Poeverlein, *B. Bayer. Akad. Wiss.*, **175** (1948)] The magneto-nic theory underlying the theoretical calculation of dio wave trajectories in the ionosphere is briefly nsidered. W. J. G. BEYNON

538.566.3 : 621.396.11

602. Coupling of the ordinary and extraordinary ays in the ionosphere. T. L. ECKERSLEY. *Proc. hys. Soc. Lond. B*, **63**, 49–58 (*Jan.*, 1950).

An approximate solution to the wave equation is iven for propagation in an ionosphere in which the radient of the density N is in the vertical, z, direction nly, and in which account is taken of the earth's agnetic field. It corresponds exactly to the ray eory and expresses a quantity Z, which is the z erivative of the phase function S, by a quartic quation. Z can be represented as a function of ζ which is $\propto N$) on a four-sheeted Riemann surface, nd the branch points are studied for the case of ertical incidence for which Z becomes the refractive dex. By considering the branch points in the mplex ζ plane, the amount of the coupling between e ordinary and the isolated extraordinary branches f the (Z, ζ) curves can be expressed as a function f the obliquity of the magnetic field. The triple litting of rays reflected from the ionosphere, bservable where the field is nearly vertical, can thus e explained, and the theory is substantiated by the bservation that the polarizations of the echoes on e (P', f) records are ordinary, ordinary and extra-rdinary in order of increasing critical frequencies, s given by the branches of the (Z, ζ) curves. A.

538.569.3

503. Absorption of ultra high-freqeuncy radio aves in organic liquids. S. C. SIRKAR AND S. N. SEN. Letter in *Nature, Lond.*, **164**, 1048–9 (*Dec.* 17, 1949).

Gives curves of dielectric loss at 31°c, from 360 to 520 Mc/s for glycerine, xylene and acetone. Benzene and CCl_4 show no loss. D. H. WHIFFEN

MAGNETIC EFFECTS 538.6

538.614 : 535.324

2604. The magnetic double refraction of liquid mixtures. II. Toluene, and carbon disulphide, in various solvents, and relation of MDR to refractive index. E. J. BÜRGE AND O. SNELLMAN. *Phil. Mag.*, **40**, 1233–44 (*Dec.*, 1949).

Measurements of the refraction in CS_2, CCl_4 and in cyclohexane are given. Solutions of toluene in CCl_4, cyclohexane and heptane are studied with regard to both magnetic double refraction and refractive index. Anomalies observed for the heptane solutions remain in the magnetic measurements after purification of the components, showing that magnetic double refraction is more sensitive than refractive index to structural alterations in solutions. L. S. GODDARD

538.632

2605. The Hall effect in rhodium. P. O. GEHLHOFF AND E. JUSTI. *Z. Naturforsch.*, **4a**, 561–2 (*Oct.*, 1949) *In German.*

The experimental value of the Hall coeff. was found to be $+505\times10^{-6}$ at 18°c, to be compared with Justi's recent value for Ru ($+2\,200\times10^{-6}$) [Abstr. 1761 (1950)] and the values for Pd and Pt (-680×10^{-6} and -196×10^{-6} respectively), the latter value also being due to the authors. E. P. WOHLFARTH

538.652

2606. Change of sign of the magnetostriction coefficient due to tension. W. BRAUNEWELL AND E. VOGT. *Z. Naturforsch.*, **4a**, 491–5 (*Oct.*, 1949) *In German.*

Whereas the so-called Villari reversal for Fe is caused by successive 90° boundary movements and rotational processes, a different type of reversal has been observed with a Heusler alloy and Fe–Ni alloys. This reversal is caused by the application of elastic stresses. The effect may either be caused by a change in the spontaneous lattice distortion due to the applied tension or may be due to a rotation, under certain circumstances, of the magnetization vectors away from the direction of tension, in spite of positive magnetostriction. E. P. WOHLFARTH

538.653

2607. Effect of tension on magnetization curves. K. H. STEWART. *Rep. Brit. Elect. Res. Ass.* (*Ref. No. N/T47*) 1–12 (1949).

An account is given of the process of magnetization in a single crystal specimen which has a tension applied in the same direction as the magnetic field. It is shown that by considering fully the effects of demagnetizing fields, results are obtained which agree well with experiment and remove some discrepancies of the older domain theory. A.

538.69

2608. A new gyromagnetic effect. S. J. BARNETT AND L. A. GIAMBONI. Letter in *Phys. Rev.*, **76**, 1542 (*Nov.* 15, 1949).

In this experiment, suggested by Einstein, a long rod is strongly magnetized along its axis, and a weak oscillating magnetic field is applied in a perp. direction. There is thus produced, in a direction perp. to both fields, a gyromagnetic intensity (∝ the gyromagnetic ratio), and an accompanying magnetization. Some results for compressed Permalloy powder are given.

P. M. DAVIDSON

538.69

2609. On movements of small ferromagnetic particles in inhomogeneous magnetic fields. F. BLAHA. *Proc. Phys. Soc. Lond. B*, **163**, 12–14 (*Jan.*, 1950).

Ferromagnetic particles of diameter from 10^{-3} to 10^{-5} cm when exposed to light move along the lines of force of an inhomogeneous magnetic field. It does not seem possible to explain the movement when only dipole properties of the particles are taken into account. Field strengths of 10^{-2} gauss are sufficient to cause distinct movement. The motions resemble those of electrically charged particles in electric fields.

A.

538.69 : 532.59

Experimental investigations of magneto-hydrodynamic waves. *See Abstr.* 2230

MOLECULAR STRUCTURE 539.13

539.132

2610. The normal vibrations of polyatomic molecules as calculated by Urey–Bradley field. III. A table of force constants. T. SIMANOUTI. *J. Chem. Phys.*, **17**, 848–51 (*Oct.*, 1949).

Assuming the Urey–Bradley field for various chemical structures, stretching, bending and repulsive force constants were determined so as to give the best fit with the observed vibration frequencies. The magnitude of these force constants, especially of repulsive constants, was discussed. [See Abstr. 413 (1950)]

A.

539.132

2611. Vibrations of a H mixture [bond] and dispersion spectra. E. F. GROSS AND V. I. VALKOV. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 4) 619–22 (1949) *In Russian.*

The intermolecular H bond causes the O–H vibration $\sim 3\,560\ cm^{-1}$ in the combination dispersion spectrum to be shifted towards lower frequency and spread into a broad band. Shift and spread vary with the compound containing the O–H group, sometimes spread from 3 600–3 200 cm^{-1}; in this band 2–3 maxima can be distinguished. Thus intermolecular H bonding is only indirectly observed; it must also occur directly near small frequencies caused by H vibration itself. The normal frequency 175 cm^{-1} is present in many liquids containing O–H; lines 350 and 500 cm^{-1}, also observed, may be overtones.

J. JACOBS

539.132

2612. Variation of Coulomb integrals of the method of molecular orbitals under the effect of free valence. A. LAFORGUE *C.R. Acad. Sci., Paris*, **229**, 1234–6 (*Dec.* 5, 1949) *In French.*

In conjugated systems the electronegativity decreases as the free valence L increases. Small variations in the Coulomb integral α are now related to L, and small ionizations of C atoms of some hydrocarbons are deduced. $\Delta\alpha$ is of order $0{\cdot}05\,\beta$, Δq is of order $0{\cdot}02$ where q is electronic charge.

J. JACOBS

539.132

2613. New interpretation of force constants of molecular potential functions. J. J. FRIPIAT. *Ann. Soc. Sci., Brux.*, **63** (*Sér.* 1) 181–250 (*Dec.* 17, 1949) *In French.*

The force constant f of a bond X–Y consists of several components which are related separately to properties of the bond and atoms. $f = A_{x-y} + B_x x_x + B_y x_y$. x_x, x_y are inverses of polarizabilities (or rigidities) of X, Y; B_x, B_y are constants depending on positions of X, Y in the periodic table; A_{x-y} is a constant of the bond X–Y, independent of X, Y separately, and varies with hybridization. $B_x x_x$ measures the deformability and is a function of the electronic oscillators of X, Y in the molecule; it varies with direction and magnitude of permanent moments and with resonances between ionic structures. It is possible to establish a quantitative relationship between f and variations of electronic structure, hybridization and resonance of molecules.

J. JACOBS

539.132

2614. Resolution of a secular determinant by the method of polygons. I. SAMUEL. *C.R. Acad. Sci., Paris*, **229**, 1236–7 (*Dec.* 5, 1949) *In French.*

A non-diagonal term is represented by a segment i, k. A polygon p_m of m sides whose vertices are the indices $i, k \ldots$ represents a product p_m. Determinants are expanded in terms of p_m, which are ± 1 in the case of molecular orbital secular determinants.

J. JACOBS

539.132

2615. Notes on the secular determinant in molecular orbital theory. C. A. COULSON. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 1) 202–5 (1950).

An expansion in decreasing powers is given in which the coeffs. are simple functions of the polygons occurring in the molecule. The roots lie between $\pm$ the max. sum of non-diagonal term moduli of a row. The coeff. of the energetically lowest molecular orbital are shown to be all of the same sign.

J. JACOBS

539.132 : 535.343

Vibration-rotation bands of some polyatomic molecules. *See Abstr.* 2343

539.133

2616. Electric dipole moment studies. I. An analysis of the moments of ethylene oxide and its homologues. W. L. G. GENT. *Trans. Faraday Soc.*, **45**, 1021–8 (*Nov.*, 1949).

539.133 : 535.343–14

2617. The rotational Stark spectrum of linear molecules. H. K. HUGHES. *Phys. Rev.*, **76**, 1675–7 (*Dec.* 1, 1949).

In the electric resonance method of radiofrequency spectroscopy various molecular and nuclear para-

ters of linear polar molecules may be determined m observations of the $1, 0 \rightarrow 1, \pm 1$ transition. equation is given for the energy difference of these o states which is good to terms in λ^6 up to values $\lambda = 1{\cdot}0$, where λ is a quantity which is $\propto$ the ctric field strength. From this equation, expres- ns are derived for the permanent electric dipole oment and the moment of inertia in terms of perimentally determined parameters. A.

539.133 : 535.347

On the calculation of molecular dichroism. *See* ostr. 2354

TOMIC STRUCTURE . ISOTOPES 539.15

539.152.1

618. Nuclear quadrupole moments and nuclear hell structure. C. H. TOWNES, H. M. FOLEY AND . LOW. Letter in *Phys. Rev.*, **76**, 1415–16 (*Nov.* 1, 949).

The general trend of nuclear quadrupole moments n a simple shell structure theory is in good agreement ith experiment, but for some isotopes (e.g. In^{113}, n^{115}, Sb^{123}, Lu^{176}) experimental values are $\gg$ those iven by theory. A. O. STANESBY

539.152.1

619. A contribution to the problem of the structure f the atomic nucleus: the N_8P_4 body. O. MONECKE. *Experientia*, **5** (*No.* 11) 440–1 (1949) *In German.*

From a consideration of discontinuities in the curve f $(N - Z)$ against $(2Z - N)$, Z being the atomic umber, and N the number of neutrons in the nucleus, or the stable nuclei, the existence of subnuclei onsisting of 4 protons and 8 neutrons is deduced. J. HUGHES

539.152.2

620. Nuclear magnetic moments and hyperfine tructure of the rubidium isotopes. F. BITTER. Letter n *Phys. Rev.*, **76**, 150 (*July* 1, 1949).

A recent determination [*ibid.*, **75**, 1326 (1949)] $(Rb^{87})/\mu(Rb^{85}) = 2{\cdot}0327 \pm 0{\cdot}001$ by the magnetic esonance method is significantly different from $\cdot 0261 \pm 0{\cdot}003$ obtained from hyperfine structure Abstr. 2977 (1940)]. It is suggested that this effect s due to different magnetic structure of the 2 nuclei, n the basis of a previously proposed vector model, hus modifying the interaction with the optical lectron, and hence the fine structure. The alternate ossibility that the effect is due to different spreading f the nuclear charge for the 2 isotopes is rejected. B. ROSE

539.152.2

621. Anomalous magnetic moments of nucleons. . D. DRELL. Letter in *Phys. Rev.*, **76**, 421 (*Aug.* 1, 949).

Earlier work [Abstr. 522 (1950)] is extended to the alculation of these moments using 3rd-order per- urbation theory, with either scalar or pseudoscalar esons, and charged or symmetric theory. The esults agree with those of other earlier authors using ifferent methods. In this calculation only the roton mass needs renormalization. G. J. KYNCH

539.152.2

2622. Magnetic moment of La^{139}. W. C. DICKINSON. Letter in *Phys. Rev.*, **76**, 1414–15 (*Nov.* 1, 1949).

The ratio of the frequency of the nuclear magnetic resonance of La^{139} to that of the proton has been measured at 6 700 gauss using a double-bridge magnetic resonance absorption method. The results indicate a value of $0{\cdot}98876 \pm 0{\cdot}00010$. G. F. HODSMAN

539.152.2

2623. Nuclear paramagnetism. M. SOUTIF. *J. Phys. Radium*, **10**, 61–78*D* (*Nov.*, 1949) *In French.*

Experiments from which the nuclear magnetic moment can be obtained are surveyed, in particular nuclear induction and nuclear resonance absorption methods and results. A bibliography is given. J. HUGHES

539.152.2

2624. Nuclear moments of Mg^{25}. M. F. CRAWFORD, F. M. KELLY, A. L. SCHAWLOW AND W. M. GRAY. Letter in *Phys. Rev.*, **76**, 1527–8 (*Nov.* 15, 1949).

From study of the h.f.s. of the Mg I lines 5 184, 5 173 and 5 167, and Mg II 2 796 Å, produced in an atomic beam light source, the spin was found to be 5/2, the mag. moment $-0{\cdot}96 \pm 0{\cdot}07$ n.m. B. ROSE

539.152.2

2625. Nuclear moments of $_{39}Y^{89}$. M. F. CRAWFORD AND N. OLSON. Letter in *Phys. Rev.*, **76**, 1528 (*Nov.* 15, 1949).

From measurements of the h.f.s. of the Y III resonance line 2 817 Å the spin was found to be $\frac{1}{2}$ and the mag. moment $-0{\cdot}14$ n.m. B. ROSE

539.152.2

2626. The nuclear spin of He^3. A. E. DOUGLAS AND G. HERZBERG. Letter in *Phys. Rev.*, **76**, 1529 (*Nov.* 15, 1949).

From study of the alternating intensity in the band spectrum of the molecule He_2^3 at 6 400 Å, the nuclear spin was found to be $\frac{1}{2}$, and the He^3 nuclei followed Fermi statistics. B. ROSE

539.152.2

2627. On the magnetic moments of Sn^{115}, Cd^{111}, Cd^{113}, Pt^{195}, and Hg^{199}. W. G. PROCTOR AND F. C. YU. Letter in *Phys. Rev.*, **76**, 1728–9 (*Dec.* 1, 1949).

539.152.2

2628. The effect of nuclear motion on atomic magnetic moments. M. PHILLIPS. *Phys. Rev.*, **76**, 1803–4 (*Dec.* 15, 1949).

The effect of the finite mass of the nucleus on the Zeeman pattern of multi-electron atoms is investigated. This effect consists of two parts, one due to the motion of the core and nucleus about the centre of mass, the other an exchange phenomenon between the electrons themselves. Both are of order m/M, where M is the mass of the nucleus. A.

539.152.2

2629. On the spatial alignment of nuclei. R. V. POUND. Letter in *Phys. Rev.*, **76**, 1410–11 (*Nov.* 1. 1949).

The use of magnetic fields for orientation may prove difficult, because a strong field is needed to cause the alignment, whereas an ordered assembly is

possible only at temps. reached by adiabatic demagnetization. The interaction between nuclear electric quadrupole moments and a crystalline electric field might be used instead. If paramagnetic ions could be incorporated in the crystal, cooling by adiabatic demagnetization would be simple. Degeneracy would not be completely removed, but the alignment would be sufficiently unambiguous for studies of angular distributions in nuclear radiative processes. A. P. FRENCH

539.152.2 : 536.48

2630. Attempts to detect alignment of atomic nuclei. C. J. GORTER, D. DE KLERK, O. J. POPPEMA, M. J. STEENLAND AND H. DE VRIES. Letter in *Physica*, **15,** 679 (*Sept.*, 1949).

Emission of γ-rays from radioactive Fe in FeAl, cooled to $\sim 0{\cdot}1°K$ by demagnetization from 20 000 oersted and $1{\cdot}2°K$ to 1 000 oersted, was found to be $2 \pm 1\%$ lower in the direction of field than perp. to the field. Observations on the total absorption of thermal neutrons in Gd sulphate cooled to a similar temp. indicated a reduction in total absorption when the neutron spins are in alignment with the field. L. R. SHEPHERD

539.153

2631. The geometrical structure of the *K* and *L* electron shells of light atoms. M. A. BESSO. *Helv. Phys. Acta*, **22** (*No.* 6) 619–21 (1949) *In French.*

The properties of the electronic shells of light atoms are discussed by analogy with the geometrical symmetries of plane polygons and regular polyhedra. J. HUGHES

539.153

2632. Atomic binding energies. W. E. DUNCANSON AND C. A. COULSON. Letter in *Nature, Lond.*, **164,** 1003–4 (*Dec.* 10, 1949).

The values of the associated total electronic energies are listed, which result from calculations of analytical wave-functions of the ground states of atoms Li to Ne [Abstr. 927 (1944)]. G. J. KYNCH

539.153.1

2633. On the atomic radius deduced from electronic interactions. R. FORRER. *C.R. Acad. Sci., Paris*, **229,** 349–51 (*Aug.* 1, 1949) *In French.*

See Abstr. 3572, 7406 (1949).

539.155

2634. Limits of energy and trans-uranium elements. J. PLOTNIKOW. *Öst. Chem.-Ztg*, **48,** 188–92 (1947) *In German.*

A method for determining the limiting atomic weight for a stable element is devised. BRITISH ABSTRACTS

539.155

2635. Place in periodic system and electronic structure of the heaviest elements. G. T. SEABORG. *Nucleonics*, **5,** 16–36 (*Nov.*, 1949).

A summary of the evidence pointing to the fact that the 5*f* electron shell is being filled in the heaviest elements. L. R. SHEPHERD

539.155.2

2636. A table of relative abundances of nuclear species. H. BROWN. *Rev. Mod. Phys.*, **21,** 625–34 (*Oct.*, 1949).

A new table of relative abundances of nuclear species existing in nature has been prepared based upon the best available data on the compositions of the sun, stars and meteorites. The general methods utilized in compiling the table are explained. A

539.155.3

2637. On the abundance of I^{129}, Te^{118} and Pt^{190}. W. T. LELAND. Letter in *Phys. Rev.*, **76,** 992 (*Oct.* 1, 1949).

Using a Nier mass spectrometer, the abundance of I^{129}, Te^{118} and Pt^{190} were found to be $< 3 \times 10$ (relative to I^{127}), 0·012% and $< 0{\cdot}0003\%$ respectively. B. ROS

539.155.3

2638. On the occurrence of vanadium 50 in nature. D. C. HESS, JR. AND M. G. INGHRAM. Letter in *Phys. Rev.*, **76,** 1717 (*Dec*, 1, 1949).

539.155.2 : 523.87

The intensities of isotopic carbon bands in the spectra of twenty-one *R*-type stars. *See Abstr.* 2169

539.155.2 : 533.1

Enrichment of the heavy xenon isotopes. *See Abstr.* 2239

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.0

2639. On the standardization of ThC″ γ-sources. R. BOUCHEZ. *J. Phys. Radium*, **10,** 415–16 (*Dec.* 1949) *In French.*

The value of the mgm–Ra-equivalent of RTh or Th active deposit as defined at the Inst. de Radium Paris [*Phil. Mag.*, **43,** 1038 (1922)] has been recalculated from the latest data to be $4{\cdot}00 \times 10^7 \pm 1\%$ dis/sec, of ThC, and emits $1{\cdot}36 \pm 0{\cdot}015 \times 10$ photons/sec of 2·61 MeV. The computation is based on the original measurements of Ricou [*J. Phys. Radium*, **8,** 388 (1937)] and Winand [*J. Phys. Radium*, **10,** 361 (1939)]. B. ROS

539.16.0

2640. Absolute measurements of the activity of beta emitters. J. L. PUTMAN. *Brit. J. Radiol.*, **22,** 42–6 (*Jan.*, 1950).

An account of counting methods used to determine the absolute disintegration rate of radio-isotopes which emit one β-particle per disintegration. Two main methods of measurement are discussed. Their limitations are stated and the corrections necessary for accurate work are explained. A third method is outlined. The β–γ coincidence method is suitable for assay of isotopes which disintegrate by the emission of a β-particle and one or more γ-rays. Defined solid angle methods are especially suitable for pure β-emitters. Two equipments are described, one using a windowless counter of a demountable type. A 4π solid angle counter with an internal source is suggested, particularly for the assay of positron emitters. Liquid counters used as sub-standards are described and methods of ensuring reproducible results are given. A résumé is made of the present state of agreement, between various observers, upon absolute standards of activity. The bases of measure

nt are stated for British Standards of activity of ^{24}, P^{32} and Co^{60} for 1949. A.

539.16.08 : 536.6

1. Calorimetric radioactivity measurements. E. MYERS. *Nucleonics*, **5**, 37–47 (*Nov.*, 1949).

A review of calorimetric methods for measuring ensities of α-, β- or γ-radiations from strong sources. rious types of microcalorimeter are described, ne of them capable of measuring heat production low as 0·01 cal/hr to accuracies of about 1–2%. lorimetric methods can yield greater accuracy than unting methods especially with sources of $>$ 1 mc. easurements which have been made by such techiques include the determination of the ½-life of Pu^{239} $2{\cdot}41\times10^4$ yr by Stout and Jones and the mean ergy of T β-particles (5·69 keV) by Jenks, Ghormley d Sweeton, both with probable errors $\leqslant 1\%$.

L. R. SHEPHERD

539.163

2642. Study of the radioactivity of samarium by the otographic method. E. PICCIOTTO. *C.R. Acad. Sci., ris*, **229**, 117–19 (*July* 11, 1949) *In French.*

The tracks obtained in Ilford C_2 plates showed a ngle range only, of $7{\cdot}04 \pm 0{\cdot}03\,\mu$. There were proton tracks. Using the double-emulsion method bstr. 2842 (1950)], a ½-life of $6{\cdot}7 \pm 0{\cdot}4\times10^{11}$ yr as found, in agreement with an early determination bstr. 3642 (1934)]. B. ROSE

539.163.1

2643. Some more lower limits of half-lives for -decay. F. BESTENREINER AND E. BRODA. Letter in *ature, Lond.*, **164**, 919–20 (*Nov.* 26, 1949).

The determinations of these limits for Ti, Zn, Sr, s and Pr have been carried out by means of the uclear track emulsion technique. The nuclei were ntroduced into the plates by immersion into a olution containing the element under investigation nd the ½-lives were evaluated from track counts of -particles. Tracks due to members of the radioactive eries were excluded from the counts. The ½-lives f Ti, Zn, Cs and Pr were found to be $>4\times10^{15}$ yr nd that of Sr $>3\times10^{15}$ yr. The absence of an nknown group of α-rays in salts of Nd ($Z = 60$) and m ($Z = 62$) has been taken as evidence against the atural existence of an α-active isotope of element ($Z = 61$). [See Abstr. 2647 (1950)]. R. H. HERZ

539.163.1

2644. A metastable state of half-life 13×10^{-8} sec. $_{71}Lu^{177}$. F. K. MCGOWAN. Letter in *Phys. Rev.*, **6**, 1730–1 (*Dec.* 1, 1949).

539.163.1

2645. The decay scheme of Hf^{181}. A. LUNDBY. *hys. Rev.*, **76**, 1809–11 (*Dec.* 15, 1949).

The radiations of Hf^{181} have been studied with elayed coincidence and absorption techniques. o γ-rays are found to precede the formation of the 0 μsec metastable state in Ta^{181}, thus confirming the ecay scheme of Chu and Wiedenbeck. From the alues of the internal conversion coeffs. together ith delayed coincidence absorption measurements is concluded that the previously reported 0·134 MeV -ray is most probably emitted from another metaable state of about 1 sec duration in Ta^{181}. A eoretical discussion of the multipole order of the ifferent radiations leads to assignments of probable spin and relative parity values to the excited states of Ta^{181}. Beginning with the ground state, the deduced spin and parity values are: $7/2(\pm)$, $1/2(\pm)$, $5/2(\pm)$ and $1/2(\mp)$. A.

539.164

2646. Contribution to the study of the radioactivity of samarium. C. HAENNY, M. NAJAR AND M. GAILLOUD. *Helv. Phys. Acta*, **22** (*No.* 6) 611–14 (1949) *In French.*

The ratio in C_2 emulsions of the numbers of long-range tracks to normal tracks was found to be different for 2 different samples of Sm (1 and 2% resp.). The long-range tracks had the range of Po α's ($22{\cdot}37 \pm 0{\cdot}08$ and $22{\cdot}30 \pm 0{\cdot}07\,\mu$), the Sm α-range being 7·05, 7·04 and 7·08, all $\pm 0{\cdot}02\,\mu$, in agreement with recent work [see Abstr. 2642 (1950)]. Using G_5 plates, electrons were shown to be associated with some of the long-range tracks, very roughly in the same abundance (2%) as those associated with Po α-tracks obtained by soaking the plates in a solution of RaD. The long-range group is therefore assigned to RaD contamination. The ranges of Sm and Po α's in G_5 emulsions was $7{\cdot}86 \pm 0{\cdot}03$ and $24{\cdot}1 \pm 0{\cdot}04\,\mu$ resp. B. ROSE

539.164

2647. An examination of praseodymium, neodymium and samarium for α-activity. F. BESTENREINER AND E. BRODA. Letter in *Nature, Lond.*, **164**, 658–60 (*Oct.* 15, 1949).

Experiments on Pr, Nd and Sm using the technique of Abstr. 1163 (1950), gave lower limits of ½-life for α-decay of $1{\cdot}3\times10^{15}$ yr for Pr, $2{\cdot}6\times10^{14}$ yr for Nd; the intensity of any second group of Sm α-particles is $<1\%$ of the 1·13 cm group; the present activity (abundance/½-life) of element 61 in rock is $\gtrsim 3\%$ of that of Sm. The unidentified pleochroic halo in mica (1·8 cm air-equiv.) [Abstr. 3234 (1934)] is probably not due to Pr, but if it is, Pr is short-lived and is, or was, replenished from a long-lived source.

A. O. STANESBY

539.164

2648. The range of thorium α-particles. H. KORSCHING. *Z. Naturforsch.*, **4a**, 563 (*Oct.*, 1949) *In German.*

The ranges of U and Th α-particles in Ilford *B*1 emulsion were: U I: $16{\cdot}3 \pm 0{\cdot}2\,\mu$; U II: $19{\cdot}0 \pm 0{\cdot}2\,\mu$; Th: $15{\cdot}1_5 \pm 0{\cdot}2\,\mu$. J. HUGHES

539.164

2649. Range-energy curve for α-particles of about 2 MeV energy. J. WALKER. Letter in *Nature, Lond.*, **164**, 837–8 (*Nov.* 12, 1949).

539.164 : 537.542

Range of α-particles emitted by Pu^{239}. *See Abstr.* 2523

539.164 : 537.563

Relative yields of ions produced by α-particles in air and water vapour. *See Abstr.* 2526

539.165

2650. On the relation between the transition probabilities for *K*-capture and positron-emission. R. BOUCHEZ, S. R. DE GROOT, R. NATAF AND H. A. TOLHOEK. *Physica*, **15**, 863–4 (*Oct.*, 1949).

The ratio of the probability of *K*-capture to that of positron emission in Cu^{61} has been carefully redetermined and a value of $0{\cdot}38 \pm 0{\cdot}08$ obtained.

This value corresponds more closely to the theoretical ratio 0·3, than do earlier results. L. R. SHEPHERD

539.165

2651. Instrumental distortions in the shapes of continuous beta-spectra. G. E. OWEN AND C. S. COOK. *Rev. Sci. Instrum.*, **20,** 768–72 (*Nov.*, 1949).

The positron spectrum of Cu^{61} and the negatron spectrum of P^{32} have been studied in a 5·7 cm radius of curvature magnetic spectrometer using a variety of vacuum chamber sizes and baffle designs. Conclusions are drawn from these data concerning the distortions in continuous β-spectra caused by scattering from the finite geometry of the chamber. A.

539.165

2652. The Sm^{151} beta-ray spectrum. B. H. KETELLE AND G. W. PARKER. Letter in *Phys. Rev.*, **76,** 1416–17 (*Nov.* 1, 1949).

The long-lived ($\sim$ 200 yr) Sm^{151} activity was separated from fission products by means of an ion exchange column. The purified Sm was deposited as chloride to form a 1 mg/cm² thick source which was examined in a thin lens spectrometer. A Kurie plot revealed a β-ray end-point of 79 keV. Two weak higher energy components were attributed to Eu^{155} which was known to be present.

L. R. SHEPHERD

539.165

2653. The radiations of tantalum^{182}, rhenium$^{186, 188}$, and gold^{199}. L. A. BEACH, C. L. PEACOCK AND R. G. WILKINSON. *Phys. Rev.*, **76,** 1585–91 (*Dec.* 1, 1949).

A survey of the radiations of Ta^{182}, $Re^{186, 188}$ and Au^{199} has been made down to energies of the order of 5 keV with a small 180 degree spectrometer. The disintegration scheme of Ta^{182} is complex. The 20 or more conversion lines found superimposed on the β-ray spectrum and the numerous peaks found in the photoelectron spectrum are analysed into 17 γ's in the energy region 80 to 330 keV. In addition, 3 γ-rays of energies 1·13, 1·22 and 1·24 MeV are found. The continuous spectrum has an end point at 0·53 MeV. The radiations of Re^{186} consist of a single β-ray group of max. energy 1·07 MeV and 2 γ-rays of energies 0·138 and 0·212 MeV. The 0·138 MeV γ-ray is converted. Coincidence experiments strongly suggest that the mode of decay is one involving the emission of a single β-ray group, followed by the cascade emission of the 2 γ-rays. The disintegration of Re^{188} is more complicated. A single group of β-rays is found with the end-point at 2·10 MeV. 5 γ-rays with energies essentially the same as those reported by Miller and Curtiss are present. All the radiations of Au^{199} lie below 0·32 MeV. Superimposed on the β-ray spectrum are 8 conversion lines that may be attributed to 4 γ-rays having energies of 0·024, 0·051, 0·156 and 0·207 MeV. The β-rays have a max. energy of 0·32 MeV. A possible decay scheme is suggested. A.

539.165

2654. The radiation spectra of barium^{140} and lanthanum^{140}. L. A. BEACH, C. L. PEACOCK AND R. G. WILKINSON. *Phys. Rev.*, **76,** 1624–8 (*Dec.* 1, 1949).

The radiations of Ba^{140} and La^{140} have been measured with a small 180° spectrometer. For the case of Ba^{140} 3 γ-rays are present, all of which are converted, with energies 0·16, 0·31 and 0·54 MeV. The β-ray spectrum shows the presence of 2 groups with maximum energies of 0·48 (40%) and 1·02 (60%) MeV. The radiations of La^{140} are complex: 6 γ-rays of energies 0·093?, 0·335, 0·49, 0·82, 1·60 and 2·5 MeV are present, the first 3 being internally converted. The β-ray spectrum is resolved into 3 groups with end-points at 1·32 (70%), 1·67 (20%) and 2·26 (10%) MeV. Decay schemes for these isotopes are suggested.

539.16

2655. Radioactive Y^{84}, Y^{88}, and Zr^{87}. B. H. ROBERTSON, W. E. SCOTT AND M. L. POOL. *Phys. Rev.*, **76,** 1649–50 (*Dec.* 1, 1949).

A 3·7 hr activity, assigned to Y^{84}, has been obtained by bombardment of Sr^{84} with 10 MeV deuterons. Characteristic radiations are 2·0 MeV positrons, X-rays and γ-rays. A 2·0 hr activity, assigned to Zr^{87}, has been obtained by bombarding natural Sr and Sr^{84} with 20 MeV α-particles. Characteristic radiations are 2·0 MeV positrons, X-rays and γ-rays. Bombardments of $Sr^{87} + d$, $Y + n^f$ and Rb + α are in agreement with the assignment of a 105 h activity to Y^{88} but show no evidence of a 2·0 hr positron activity previously assigned to Y^{88}.

539.16

2656. On the γ-radiation of radiothorium. M. RIOU. *C.R. Acad. Sci., Paris,* **229,** 1225–7 (*Dec.* 5, 1949). *In French.*

By the method of selective absorption, the 14 keV radiation is shown to be Ra *L*-radiation, the $\sim$ 80 keV radiation to have energies 84·00 $\pm$ 1·15 and 86·48 $\pm$ 1·33 keV, being definitely not Ra *K*-radiation. The intensities are 7 $\pm$ 1·5, 1·8 $\pm$ 0·5 and 0·7 $\pm$ 0·3 quanta respectively per 100 disintegrations. B. ROSS

539.16

2657. Internal pair creation in Na^{24}. E. R. RAE. *Phil. Mag.*, **40,** 1155–8 (*Nov.*, 1949).

The internal pair-creation coeff. of the 2·76 MeV γ-ray line from Na^{24} was measured and found to lie very close to the curve of electric dipole transitions predicted by Jaeger and Hulme for $Z = 0$. This suggests that measurement of the coeff. for high energy transitions in light nuclei may provide a useful method of determining multipole order. Assuming that the 2·76 MeV line is of dipole origin, an energy level diagram is constructed for the Mg^{24} nucleus.

L. S. GODDARD

539.16

2658. Interference effects in gamma-gamma angular correlations. D. S. LING, JR. AND D. L. FALKOFF. *Phys. Rev.*, **76,** 1639–48 (*Dec.* 1, 1949).

The theory of the directional correlation of successive nuclear γ-rays is extended to include transitions in which mixtures of multipoles are present. For such cases interference effects can radically modify the angular correlation from what is predicted in the usual theory assuming pure multipole transitions. Correlation functions are tabulated for all possible cascade emissions in which one of the transitions is a mixture of magnetic dipole and electric quadrupole and the

er either dipole or quadrupole. It is shown that experimental data on Sr^{88} which had previously med anomalous can be consistently interpreted h the mixture theory developed here, but the agree- nt with the observed angular correlation in Pd^{106} not possible if the highest γ-multipole order is umed to be quadrupole. A.

539.166

59. Precision wave-length measurements of the 1- and 1·3-Mev lines of Co^{60} with the two-meter using curved-crystal spectrometer. D. A. LIND, R. BROWN AND J. W. M. DUMOND. *Phys. Rev.*, , 1838–43 (*Dec.* 15, 1949).

Recent improvements in this spectrometer [see ostr. 4052 (1949)] are described which have extended quantum energy range well above 1 MeV and ve also yielded much better luminosity and resolving wer than were obtained initially. The improved mponents are: (1) the crystal holder, whose aper- re and resolving power have been nearly doubled d (2) the collimator, the new model of which can w discriminate between the reflected and transmitted ams when these differ in direction by only 8′ of c, a threefold improvement over the first model. ans for further possible improvements and the ctors governing these are also discussed. Wave- ngths of 2 γ-rays emitted following β-decay of Co^{60} ve been measured with this new equipment using source of about 50 mc strength and found to have lues of $(9{\cdot}308 \pm 0{\cdot}005)\times 10^{-11}$ cm and $(10{\cdot}580 \pm 005)\times 10^{-11}$ cm corresponding to quantum energies $1{\cdot}3316 \pm 0{\cdot}0010$ MeV and $1{\cdot}175 \pm 0{\cdot}0010$ MeV, spectively. The lines appear to have equal inten- ties. The integrated reflection coeff. of the (310) anes of the curved-quartz crystal still appears to llow a λ^2-dependence on wavelength down to x.u., the shortest so far observed. A.

539.166

660. Study of γ-radiation from ionium. I. CURIE. *Phys. Radium*, **10,** 381–6 (*Dec.*, 1949) *In French.*

A mixture of Io and Th (9·1% Io) separated (as ydrate) from the ThX, active deposit and the Ra hich had accumulated, was investigated with a thin ·1 mm wall Al counter. The sources were deposited n thin cellophane and mounted 15–25 mm from the ounter, a diaphragm being used in some of the xperiments to define the solid angle accurately. bsorption curves in Cu and Al showed a soft adiation, identified as L X-rays of Ra and a more enetrating γ-radiation. The latter was separated nto 3 components of 68, 140 and 240 keV. The ntensities of the L X-rays and 68 keV radiations ere estimated using theoretically calculated values or the Al counter efficiencies. A similar counter ned with 0·1 mm Pb foil was used in measurements f the intensities of the γ-rays. These intensities ere found to be as follows: Ra L X-rays, 11 per 00 α-particles; 68 keV γ-rays, 0·85 per 100 α's; 40 keV γ-rays, 0·33 per 100 α's; 240 keV γ-rays, ·05 per 100 α's. L. R. SHEPHERD

539.166 : 535.343 : 537.531

Penetration and diffusion of hard X-rays through ick barriers. III. Studies of spectral distributions. *ee Abstr.* 2486

539.166 : 537.531

2661. Study of the γ- and X-rays of MTh I and MTh II. M. LECOIN, M. PEREY AND M. RIOU. *J. Phys. Radium*, **10,** 390–4 (*Dec.*, 1949) *In French.*

By the method of selective absorption, MTh II was shown to emit L-radiation of intensity 0·3 quanta/disintegration, and γ-radiation of energy > 100 keV, ~ 2 quanta/disintegration. MTh I emits L-radiation $\sim 0{\cdot}04$ quanta/disintegration, probably due to the internal conversion of a γ-ray of energy ~ 30 keV. B. ROSE

539.166.2

2662. Magnetic multipole internal conversion. N. TRALLI AND I. S. LOWEN. Letter in *Phys. Rev.*, **76,** 1541–2 (*Nov.* 15, 1949).

Calculations of magnetic internal conversion coeffs. in the Pauli approximation, for $Z = 35$ [see Abstr. 6406 (1949)] have been extended. K/L conversion ratios (expressed as a function of Z^2/E) are now given for multipole orders up to 5 (inclusive). Ratios of L_{III} to L_I conversion are also given over the same range of Z^2/E and for the same multipole orders. L. R. SHEPHERD

NUCLEAR REACTIONS 539.17

539.172.11

2663. Particle groups from the alpha-particle bombardment of boron. R. J. CREAGAN. *Phys. Rev.*, **76,** 1769–73 (*Dec.* 15, 1949).

Targets of natural B and targets of 96% B^{10} have been bombarded by 7·45 MeV and 6·64 MeV cyclotron α's. 7 charged particle groups have been observed. The Q-values calculated from the energy of the various groups have been assigned as follows: $Q_1 = 4{\cdot}07$ MeV to the $B^{10}(\alpha, p)C^{13}$ reaction; $Q_2 = 0{\cdot}85$ MeV to the $B^{11}(\alpha, p)C^{14}$ reaction; $Q_3 = 0{\cdot}31$ MeV to the first excited state of C^{13} at 3·76 MeV. Other values are: $Q_4 = 0{\cdot}07$ MeV; $Q_5 = -0{\cdot}31$ MeV; $Q_6 = -1{\cdot}57$ MeV; $Q_7 = -1{\cdot}76$ MeV with assignments discussed. The assignments were checked with B^{10} targets and p-γ-coincidence technique. γ's were detected by coincident counts from two photomultiplier tubes observing the same naphthalene crystal. Excited states of C^{13} were searched for, but not observed, at 0·8 MeV and 3·12 MeV. A.

539.172.13

2664. Angular distribution of protons, and a study of (p, γ) and (α, γ) coincidences, in the disintegration of boron by deuterons. J. THIRION. *C.R. Acad. Sci., Paris*, **229,** 1007–9 (*Nov.* 14, 1949) *In French.*

Absorption curves for disintegration protons were obtained at 0° and 90° to an incident D beam of 600 keV energy. Detection was by a proportional counter biased to record only protons near the end of their range. 3 proton groups were found, the middle one having a markedly anisotropic angular distribution. (p, γ) coincidences were observed for the 2 lower energy groups but not for the highest energy group, which ∴ presumably corresponds to formation of B^{11} in its ground state. Similar measurements on the α-particle groups from the process

$B^{10}(d, \alpha)$ revealed no (α, γ) coincidences. This would be expected if the excited states of Be^8 can break up into 2 α-particles. A. P. FRENCH

539.172.13

2665. Angular distribution of neutrons from targets bombarded by 18 MeV deuterons. P. AMMIRAJU. Letter in *Phys. Rev.*, **76**, 421–2 (*Nov.* 1, 1949).

Targets of Be, Na, Cu, Ta, Pb and Th, thick enough to stop the deuterons, were employed and the resulting neutrons were detected in Cd-covered Cu threshold detectors activated by the reaction $Cu^{63}(n, 2n)Cu^{62}$ (threshold 11 MeV). The neutrons were found to be emitted preferentially in the forward direction. The $\frac{1}{2}$-width of the distribution for a Cu target (45°) was in good agreement with the value (46°) predicted by the Serber stripping theory, that for Be target (41°) was $>$ the theoretical value (31°) and for Pb (47°) $\ll$ the theoretical figure (70°). It is possible that neutrons emitted from heavy elements at large angles may be of lower energy than those in the forward direction and may escape detection by the $Cu^{63}(n, 2n)$ reaction. L. R. SHEPHERD

539.172.13

2666. Protons from the bombardment of He^3 by deuterons. L. D. WYLY, V. L. SAILOR AND D. G. OTT. Letter in *Phys. Rev.*, **76**, 1523–4 (*Nov.* 15, 1949).

At a bombarding energy of 3·2 MeV, the angular distribution of the protons in the c.g. system was found to require a large $\cos^4\theta$ term. The protons were studied by absorption methods, showing a single group at all angles, corresponding to a Q of $18{\cdot}5 \pm 0{\cdot}2$ MeV, in agreement with Bainbridge's mass values. No excited states of He^4 lying between ground and 11·4 MeV were produced in amounts of as much as 6% of the main group. B. ROSE

539.172.13

2667. The deformation, with depth, of the decay curves of metals irradiated with deuterons. C. CHAMIÉ AND H. FILÇAKOVA. *J. Phys. Radium*, **10**, 387–90 (*Dec.*, 1949) *In French.*

More detailed results obtained than in previous paper [see Abstr. 7258 (1949)]. J. HUGHES

539.172.13

2668. Magnetic analysis of the $C^{12}(d, p)C^{13}$ and $O^{16}(d, p)O^{17}$ reactions. W. W. BUECHNER, E. N. STRAIT, A. SPERDUTO AND R. MALM. *Phys. Rev.*, **76**, 1543–7 (*Dec.* 1, 1949).

The proton groups that result from the d bomb. of C^{12} and O^{16} targets have been analysed with a high resolution magnetic spectrometer. For the $C^{12}(d, p)C^{13, 13*}$ reactions, the Q-values have been measured as $2{\cdot}729 \pm 0{\cdot}009$ and $-0{\cdot}370 \pm 0{\cdot}003$ MeV. No evidence has been found for energy levels of lower energy than the one which is thus determined to be at $3{\cdot}098 \pm 0{\cdot}008$. The reaction energies for the two proton groups observed to come from $O^{16}(d, p)O^{17}$ are $1{\cdot}925 \pm 0{\cdot}008$ and $1{\cdot}049 \pm 0{\cdot}007$ MeV, with $0{\cdot}876 \pm 0{\cdot}009$ MeV as the energy of the first excited state in O^{17}. A.

539.172.13

2669. Magnetic analysis of $Be^9(d, \alpha)Li^7$ and $Be^9(d, p)Be^{10}$ reactions. W. W. BUECHNER AND E. N. STRAIT. *Phys. Rev.*, **76**, 1547–9 (*Dec.* 1, 1949).

The α-particle and proton groups arising from the d bomb. of Be targets have been studied with a high resolution magnetic spectrometer. Except for the well-known one at 480 keV, no evidence has been found for energy levels in Li^7 between 3·4 MeV and the ground state. The Q-value for the $Be^9(d, \alpha)Li^7$ reaction has been measured as $7{\cdot}145 \pm 0{\cdot}024$ MeV. Studies of the proton groups indicate that there are no levels in Be^{10} between the ground state and one at $3{\cdot}375 \pm 0{\cdot}010$ MeV. The Q for the $Be^9(d, p)Be^{10}$ reaction has been found to be $4{\cdot}576 \pm 0{\cdot}012$ MeV.

539.172.1

2670. Magnetic analysis of the $Li^6(d, p)Li^7$ and $Li^7(d, p)Li^8$ reactions. E. N. STRAIT AND W. W. BUECHNER. *Phys. Rev.*, **76**, 1766–7 (*Dec.* 15, 1949).

The energy release of the $Li^6(d, p)Li^7$ reaction has been measured as $5{\cdot}006 \pm 0{\cdot}014$ MeV, using a semi-circular magnetic analysis. The hitherto unobserved protons from the $Li^7(d, p)Li^8$ reaction have been found and their energy measured. The Q for this reaction has been determined as $-0{\cdot}193 \pm 0{\cdot}008$ MeV.

539.172.1

2671. Absolute voltage determination of two nuclear resonances below 0·4 MeV. A. H. MORRISH. *Phys. Rev.*, **76**, 1651–7 (*Dec.* 1, 1949).

An absolute voltage determination was made of the $F^{19}(p, \alpha'\gamma)$ and the $B^{11}(p, \alpha)$ and $B^{11}(p, \gamma)$ resonances. A calibrated electrostatic analyser was used to measure the proton beam energy from a Crockroft–Walton linear accelerator. The values obtained were $0{\cdot}3404 \pm 0{\cdot}0004$ MeV and $0{\cdot}1628 \pm 0{\cdot}0002$ MeV, respectively. An approximate estimate of the $\frac{1}{2}$-width appears to give $2{\cdot}0 \pm 1{\cdot}0$ kV for the F and $4{\cdot}5 \pm 1{\cdot}5$ kV for the B resonance.

539.172.

2672. Investigations of the capture of protons and deuterons by deuterons. W. A. FOWLER, C. C. LAURITSEN AND A. V. TOLLESTRUP. *Phys. Rev.*, **7**, 1767–8 (*Dec.* 15, 1949).

The capture of protons and deuterons by deuterons has been studied up to energies of 1·5 MeV. An upper limit of $\sim 10^{-31}$ cm^2 has been found for the $D(d, \gamma)$ reaction near 1 MeV. The γ-radiation from $D(p, \gamma)$ has been found to have an angular distribution obeying a $\sin^2\theta$ law. The cross-section of the reaction is given empirically from 0·5 to 1·5 MeV by $\sigma = 0{\cdot}74E^{0{\cdot}72} \times 10^{-29}$ cm^2 for E in MeV.

539.172.13 : 539.18

Monoenergic neutrons from charged particle reactions. *See Abstr.* 2700

539.172

2673. Theory of the angular distribution of photo-neutrons from Be^9. C. J. MULLIN AND E. GUTH. Letter in *Phys. Rev.*, **76**, 682 (*Sept.* 1, 1949).

The angular distribution function is calculated on the $Be^8 + n$ model [Abstr. 4115 (1949)]. The experimentally determined function [Abstr. 50 (1950)] agrees best with the assumptions that the disintegration results from the transitions $P_{3/2} \rightarrow S_{1/2}$ and $P_{3/2} \rightarrow D_{5/2}$. B. RO

539.172.3

74. A new gamma-ray resonance in the reaction $^{12}(p,\gamma)N^{13}$. D. M. VAN PATTER. Letter in *Phys. Rev.*, **76**, 1264–5 (*Oct.* 15, 1949).

This is located at $1{\cdot}697 \pm 0{\cdot}012$ MeV with a width of 74 ± 9 keV. The thick target yield is $4 \pm 1{\cdot}4 \times 10^{-10}$ quanta per proton, which gives a diation breadth of $1{\cdot}3 \pm 0{\cdot}2$ eV. The mass fference $C^{12} + p - N^{13}$ is calculated to be $1{\cdot}963 \pm$ 015 MeV using recent data. This makes the 456 MeV [Abstr. 491 (1950)] and $1{\cdot}697$ MeV sonances correspond to levels at $2{\cdot}383 \pm 0{\cdot}018$ id $3{\cdot}53 \pm 0{\cdot}027$ MeV respectively in N^{13}, in greement with recent work on $C^{12}(d,n)N^{13}$ [Abstr. 214 (1950)]. The lack of correspondence is pointed it between these levels and those of the mirror ucleus C^{13}. B. ROSE

539.172.3

575. The angular distribution of the photo-neutrons om deuterium at 2·76 MeV. B. HAMERMESH AND . WATTENBERG. Letter in *Phys. Rev.*, **76**, 1408 *Vov.* 1, 1949).

Measurements were made, using methods previously escribed for photo-neutrons from Be [Abstr. 501 1950)]. The distribution of the D photo-neutrons is f the form $I(\theta) = a + b \sin^2\theta$, the ratio a/b was btained from measurements at 0° and 90°. D_2O argets in cylindrical holders of various diameters ere used in the experiments. Corrections were ade for finite angles subtended by source and ounter and for scattering of neutrons inside the $)_2O$, the latter by noting the variation of $I_0/I_{90°}$ with arget diameter and extrapolating to zero diameter. value of $0{\cdot}205 \pm 0{\cdot}05$ was obtained for the ratio $/b$. L. R. SHEPHERD

539.172.4

676. The transient regime of nuclear reactors. II. C. SALVETTI. *Nuovo Cim.*, **6**, 413–34 (*Nov.*, 1949) *In talian.*

[See Abstr. 1999 (1950).] The effect of delayed eutrons on the transient behaviour of a nuclear hain reactor is evaluated. It is found that the eutron density satisfies an integro-differential quation, whose general solution consists of a sum f exponentials: of these only one is of practical nterest, the others all rapidly converging. The quation giving the period of the pile as function of eactivity is discussed and safe conditions are deduced. ome numerical values of practical interest are given. A.

539.172.4

677. The reaction $^{10}B(n,\alpha)^7Li^*$ and the range-energy elation for α-particles of energy less than 2 MeV. I. FARAGGI. *C.R. Acad. Sci., Paris*, **229**, 1223–5 *Dec.* 5, 1949) *In French.*

By the method of partial fading previously escribed [Abstr. 3628 (1949)] the ranges of the α nd the Li^{7*} were found to be $5{\cdot}0 \pm 0{\cdot}2\,\mu$ and $\cdot2 \pm 0{\cdot}2\,\mu$ respectively in an Ilford C_2 plate. rom this ratio of the ranges, and previous measure- ents of total range, it is concluded that the Bethe ange-energy curve for α-particles remains valid for ow energies. B. ROSE

539.172.4

2678. A schematic theory of nuclear cross sections. H. FESHBACH AND V. F. WEISSKOPF. *Phys. Rev.*, **76**, 1550–60 (*Dec.* 1, 1949).

A description of the energy-dependence of nuclear cross-sections, especially for neutrons, is given in terms of simple assumptions on the properties of the nuclei. The results are supposed to represent average values over individual fluctuations and resonances. The total cross-section, the reaction cross-section and the transport cross-section are calculated as functions of the neutron energy. Only two nuclear parameters occur in the expressions; the nuclear radius and the average kinetic energy of a nucleon inside the nucleus. Comparison of the theory with neutron experiments is made. New values of nuclear radii are computed from total cross-sections at 14 and 25 MeV. Predictions of the inelastic cross-sections at 14 MeV are in good agreement with the measurements. Experiments involving total and transport cross-sections between 0·1 and 1·5 MeV are compared with theory and reasonably good agreement is found with most of these. However, for the elements, I, In, Sb, agreement in the context of the theory may be obtained only if the strength of resonance levels for these elements is assumed to be unusually low. A.

539.172.4

2679. A precise determination of the slow neutron cross section of the free proton. E. MELKONIAN. *Phys. Rev.*, **76**, 1744–9 (*Dec.* 15, 1949).

The total cross-sections of H, *n*-butane and water have been measured with the Columbia slow neutron velocity spectrometer in the energy range 0·8 to 15 eV. Analysis of these data gives a value of $20{\cdot}36 \pm 0{\cdot}10$ barns for the free proton cross-section. In this energy interval the measurements confirm Placzek's theoretical prediction of the variation of the H cross-section. The technique of making absolute transmission measurements and the corrections for multiple scattering are discussed. Measurements on H for neutron energies above 15 eV show a constant cross-section to several thousand eV. Measurements on fused quartz in the energy interval 0·003 eV to 10 eV show interference effects. A.

539.172.4

2680. Slow neutron velocity spectrometer studies of O_2, N_2, A, H_2, H_2O and seven hydrocarbons. E. MELKONIAN. *Phys. Rev.*, **76**, 1750–9 (*Dec.* 15, 1949).

The cross-sections of free atoms have been determined to be: O, 3·73; N, 9·96; A, 0·68 barn. Between 1 and 15 eV the N curve shows an $E^{-\frac{1}{2}}$ slope of $0{\cdot}34$ barn $\times$ (eV)$^{\frac{1}{2}}$ per atom. Measurements on these elements have been extended to over 10 000 eV with no resonances observed. Dependence of cross-section upon *n*-energy from 1 eV to 0·003 eV is presented for O, N, H, H_2O, methane, ethane, propane, *n*-butane, cetane, ethylene, 1,3-butadiene and liquid *n*-butane. At the lowest energies, the large observed H cross-section is attributed largely to thermal translational motion of the molecule. The measurements on the hydrocarbons show the effect of the binding of H in various molecules. Comparison with the theories of Bethe and Arley is made. No

difference has been detected in cross-section measurements on gaseous and liquid *n*-butane. A.

539.172.4

2681. The division of nuclear charge in fission. D. C. BRUNTON. *Phys. Rev.*, **76**, 1798–1802 (*Dec.* 15, 1949).

Recent measurements of fission fragment energies emphasize the difficulty of reconciling the variations in kinetic energy with current hypotheses of charge distribution. The assumption of close relationship between charge and kinetic energy is used here to derive a new distribution. The energy associated with each possible charge division between a pair of fragments of given masses is computed and compared with the measured energy as a function of frequency for the same mass pair. In this way a charge-frequency curve is derived on the assumption that most of the variation in fragment kinetic energy is associated with variation in the division of primary charge. The marked disagreement between the charge distribution arrived at here and previous hypotheses is discussed, and the relation between charge distribution and stable nucleon shells is considered. A.

ATOM AND MOLECULE BEAMS MESONS . NEUTRONS 539.18

539.18

2682. H^3 and the neutrino mass. H. A. TOLHOEK. *Ned. T. Natuurkde*, **15**, 96–9 (*April*, 1949) *In Dutch.*

A review of recent work on the subject, pointing out the convenience of H^3 for measuring the neutrino mass owing to the low energy of its β-spectrum. The determination is based on Fermi's theory of the β-radioactivity. B. F. KRAUS

539.18

2683. On the production of mesons. H. KOPPE. Letter in *Phys. Rev.*, **76**, 688 (*Sept.* 1, 1949).

The probability of meson emission in a nuclear collision is determined in terms of the effective temp. of the compound nucleus, and the result is compared with experimental yields (protons on C) reported by Jones and White [*Bull. Am. Phys. Soc.*, **24**, 8 (1949)]. J. G. WILSON

539.18

2684. On the production of Π-mesons by nucleon-nucleon collisions. C. MORETTE. *Phys. Rev.*, **76**, 1432–9 (*Nov.* 15, 1949).

Besides the doubts concerning the actual meson theories and the use of a perturbation method for the study of strongly coupled fields, doubts have been raised as to the validity of some approximations usually made in the computation of the cross-section for meson production by nucleon-nucleon collision. This cross-section is computed here in a relativistically invariant manner for the pseudoscalar meson (pseudoscalar coupling) with the charged and the charge symmetrical theory. The results are valid for all energies of the incoming particle. The energy distribution and the total cross-section derived from the invariant statistical factors are given as a point of comparison. Some computational tools are presented: a projection and a permutation operator and a method for the calculation of the density of state In the Appendix two different ways of considering thi meson production (mesonic analogue to the brems strahlung or third-order process) are discussed. A

539.1

2685. Note on the decay of the π-meson. M RUDERMAN AND R. FINKELSTEIN. *Phys. Rev.*, **76** 1458–60 (*Nov.* 15, 1949).

Assuming the symmetric coupling scheme pro posed by Wheeler and Tiomno, and others, thi ratio of the decay rate π-meson $\rightarrow$ electron + neutrino to the decay rate of π-meson $\rightarrow$ μ-meson + neutrino has been calculated. The electron-neutrino decay proceeds faster, in disagreement with experiment, unless the π-meson is pseudoscalar and the β-decay coupling is pseudovector. Hence if the symmetric coupling scheme is correct and no other direct couplings are introduced, the π-meson must be pseudoscalar and β-decay must be at leas partially pseudovector. If symmetric coupling is no assumed, no conclusion of this kind can be drawn. A

539.1

2686. Are mesons elementary particles? E. FERM AND C. N. YANG. *Phys. Rev.*, **76**, 1739–43 (*Dec.* 15 1949).

The hypothesis that π-mesons may be composit particles formed by the association of a nucleon with an anti-nucleon is discussed. From an extremel crude discussion of the model it appears that such meson would have in most respects properties simila to those of the meson of the Yukawa theory. A

539.1

2687. The decay and capture of μ-mesons in photo graphic emulsions. M. G. E. COSYNS, C. C. DILWORTH G. P. S. OCCHIALINI, M. SCHOENBERG AND N. PAGE *Proc. Phys. Soc. Lond. A*, **62**, 801–5 (*Dec.*, 1949).

Observations on the decay and capture of μ-meson in Kodak NT4 and Ilford G5 photographic emulsion are described. It is found, in agreement with othe workers, that $63 \pm 4\%$ of all μ-mesons stopping i the emulsion decay with the emission of a fast electron a result which is shown to be in reasonable agreemen with theoretical predictions. The emission of slo electrons is observed from $7{\cdot}2 \pm 1{\cdot}3\%$ of all slo mesons, and these are ascribed mainly to an Auge effect accompanying the capture of μ-mesons. A

539.1

2688. The decay of μ-mesons. J. H. DAVIES W. O. LOCK AND H. MUIRHEAD. *Phil. Mag.*, **40** 1250–60 (*Dec.*, 1949).

The energies of the charged particles resulting fro decay in photographic emulsions was determine using multiple scattering techniques. The result i that the energy distributon is continuous with peak in the 35–40 MeV region. The average energ is 40 MeV. The conclusion is that a μ-meson decay into an electron and two neutrinos. L. S. GODDAR

539.18

2689. An observation on the limits of detectabilit of weak molecular beams of alkalis produced b ionization on heated wolfram. F. KNAUER. *Z. Phys* **126** (*Nos* 3–4) 310–18 (1949) *In German.*

These rays may be detected (*a*) by the voltage dro

oss a resistance, (*b*) in an electrical oscillator, and with a galvanometer, and the calculation assumes tt the Schrot effect and thermal fluctuations of istance are each < the limits of experimental uracy. The number of atoms/sec is worked out terms of the measured quantities for each of the es above. C. A. HOGARTH

539.185

90. Neutron diffraction. G. E. BACON AND THEWLIS. *Proc. Roy. Soc. A*, **196**, 50–63 (*Feb.* 22, 49).

The phenomena of X-ray and neutron diffraction e compared and formulae for the scattering of utrons by perfect crystals, mosaic crystals and wder blocks are worked out. It is shown that the ction of incident energy diffracted is similar in e two cases but that the very low neutron absorption hich usually exists results in the integrated reflection r a thick mosaic crystal being practically inde- ndent of structure factor. The practical problem diffracting a collimated beam of neutrons from an omic pile is discussed and an estimate is made of e minimum number of neutrons per second in the cident beam that are necessary for the determination structure factors by the powder method. The plications of neutron diffraction are considered. J. THEWLIS

539.185

591. Methods and uses of neutron diffraction. G. SHULL AND E. O. WOLLAN. *Naturwissenhaften*, **36** (*No.* 10) 291–6 (1949) *In German.*

Surveys the recent progress in neutron diffraction ork at Oak Ridge. The differences between neutron iffraction and diffraction by X-rays and electrons e outlined, attention being paid to the values of cattering cross-sections, to spin—and isotope—isorder and to the change of phase on scattering. xperimental arrangements are discussed and a ummary is given of the application of neutron iffraction to the determination of scattering cross- ections and the positions of H atoms in crystal tructures; and to the problem of order—disorder hen the atoms concerned have nearly the same -ray scattering powers. J. THEWLIS

539.185

692. Fast neutron detector. W. G. MOULTON AND . W. SHERWIN. *Rev. Sci. Instrum.*, **20**, 766–7 (*Nov.*, 949).

A simple fast neutron detector suitable for health hysics applications has been constructed using two 31 A photo-multiplier tubes in coincidence to educe background. A "sandwich" made of Lucite nd activated ZnS is used to produce the scintillations. he efficiency of the instrument for fast neutrons om a Ra–Be source is $1{\cdot}5 \pm 50\% \times 10^{-4}$. It etects a fast neutron flux of 20 neutrons/cm² sec ith a counting rate that is > 10× background. A.

539.185

693. Passage of nucleons through matter. D. I. LOKHINTSEV. *J. Exp. Theor. Phys., USSR*, **19**, 53–8 (*Nov.*, 1949) *In Russian.*

The slowing-down of nucleons is considered, lowing for the exchange of charges between proton nd neutron. The calculation is based on experimental data of Hadley and Kelly *et al.* [Abstr. 2741 (1949)] and Cook and McMillan *et al.* [Abstr. 1081 (1948)]. The theoretical cross-section agrees surprisingly well with the experimental results. The evaluation of the approximate formula for the free path shows (except for the range of low energies) that the neutron, before it is slowed down by nuclear collisions, turns into a proton. The fate of the proton, however, is not determined by nuclear processes, but by ionization losses. The curves of distribution of neutron-proton exchanges show that at high energies the number of neutrons decreases considerably. The author stresses that the assumptions of his theory make it unfit for application to nuclei of high atomic weight, as the treatment is non-relativistic. For delimiting the field of application of the theory, the "transparency" of the nuclear matter is then determined when it is seen that in the range $E < 100$ MeV the majority of nuclei is already "opaque" (in the sense that collisions result in a total loss of energy and deflection of the nucleon). B. F. KRAUS

539.185

2694. The attenuation of neutrons of various energies in water. C. E. FALK AND E. CREUTZ. *J. Appl. Phys.*, **20**, 1183–5 (*Dec.*, 1949).

Threshold detectors (In^{115}, Ag^{107} and C^{12}) were used to determine the relative intensities of neutrons at various distances inside a large water tank. Neutrons with energies up to 30 MeV were produced by (d, n) reactions. At distances in the water > 20 cm the "half-thickness" of water was found to be almost independent of neutron energy (about 8 cm). A.

539.185

2695. The scattering of slow neutrons by paramagnetic crystals. I. W. RUDERMAN. *Phys. Rev.*, **76**, 1572–84 (*Dec.* 1, 1949).

The scattering by anhydrous crystals of manganous fluoride, manganous oxide and α-ferric oxide was studied, using neutron transmission data obtained with the Columbia slow neutron velocity spectrometer. Details are given of the experimental arrangement, which permits measurements to be made with neutrons having wavelengths up to 6·4 Å. The paramagnetic cross-section, σ_{pm}, may be separated from the total cross-section in regions where there are no interfering crystal diffraction effects. Large values of σ_{pm} were found for the manganous compounds, but no paramagnetic scattering by α-Fe_2O_3 was observed. The results are compared with the theoretical predictions of Halpern and Johnson. The dependence of σ_{pm} on the neutron wavelength was determined, and is compared with a theoretical form factor based on purely elastic scattering. A.

539.185

2696. Neutron polarization. J. FLEEMAN, D. B. NICODEMUS AND H. H. STAUB. *Phys. Rev.*, **76**, 1774–81 (*Dec.* 15, 1949).

Experiments for the determination of the polarization cross-section p of Fe with monochromatic and non-monochromatic neutrons are described. The absolute value of p as well as its dependence on the neutron velocity is found to be in good agreement with the recent calculations of Steinberger and Wick [*ibid.*, **74**, 1207 (1948)] and also with other

experiments. For a complex neutron spectrum originating from a paraffin moderator $\bar{p}$ is found to be $(2{\cdot}35 \pm 0{\cdot}1) \times 10^{-24}$ cm² in agreement with previous investigations. It is shown that the larger value of $3{\cdot}15 \times 10^{-24}$ cm² found by Hughes, Wallace and Holtzman [Abstr. 2947 (1948)] must be due to spectral differences. The approach of the magnetization of Fe towards saturation is also investigated. A.

539.185

2697. Multiple scattering of neutrons. II. Diffusion in a plate of finite thickness. O. HALPERN AND R. K. LUNEBURG. *Phys. Rev.*, **76**, 1811–19 (*Dec.* 15, 1949).

Analytic expressions are derived for the density and current of the returning and transmitted neutrons at the boundaries. Density and current distribution inside the material at sufficiently large distances from the boundaries are also calculated. A.

539.185

2698. A solid detector for the comparison of neutron sources. D. H. WILKINSON. *J. Sci. Instrum.*, **27**, 16–17 (*Jan.*, 1950).

A hollow cylinder of Mn is used as a detector of thermal neutrons which are generated by the moderation in a surrounding water tank of fast neutrons from a source placed within the detector. The activation of the detector is investigated as a function of the position within it of a very small neutron source and found to be insensitive to this position. The detector then provides an accurate and sensitive means for the comparison of neutron sources of very different sizes, such as a large Ra + Be mixed source and a small Ra–Be-fluoride neutron standard source. A.

539.185 : 523.877

2699. A new solution of Milne's problem for the diffusion of neutrons and the transfer of radiation. V. KOURGANOFF. *Ann. Astrophys.*, **12**, 169–96 (*July–Sept.*, 1949) *In French.*

The problem of the isotropic diffusion of neutrons near a plane surface depends upon the same equations as the corresponding problem of radiation transfer in stellar atmospheres. The author's variational solution derived for the latter problem [see Abstr. 3728 (1949)] is discussed in detail, and is applied to the former problem. The method is compared with other variational solutions [Abstr. 2254, 3669 (1947)] and with operational solutions [Abstr. 3667–8 (1947)].

R. A. NEWING

539.185 : 539.172.13

2700. Monoergic neutrons from charged particle reactions. A. O. HANSON, R. F. TASCHEK AND J. H. WILLIAMS. *Rev. Mod. Phys.*, **21**, 635–50 (*Oct.*, 1949).

The *n*-producing reactions are considered chiefly from the experimental view-point. Measurements of cross-sections and angular distributions are summarized, mostly in graphical form. Various other graphical aids are provided for computing *n*-energies and certain geometrical factors as functions of bombarding energy for the more important reactions. There is a fair amount of detail on preparation of targets, avoidance of contaminants, etc. Amongst the endoergic reactions, $V^{51}(p, n)$ and $Sc^{45}(p, n)$ are suggested as being of value for expts. requiring neutrons of defined energy between 2 and 40 keV.

A. P. FRENCH

STRUCTURE OF SOLIDS 539.2

539.21 : 537.311

2701. The Herzfeld metal criterion and the problem of the existence of a non-conducting amorphous modification of all metals. H. MAYER. *Z. Naturforsch.*, **4a**, 527–33 (*Oct.*, 1949) *In German.*

Herzfeld's condition [*Phys. Rev.*, **29**, 701 (1927)] derived from dispersion theory, determining whether an aggregate of atoms, in solid or liquid form, has metallic properties may be expressed as $R > M/S$, where R is the molecular refractivity, M the molecular weight and S the density. It is shown that this condition permits the interpretation of recent measurements of the electrical conductivity of thin metal films. E. P. WOHLFARTH

539.21

2702. Grain boundary diffusion of liquid bismuth in copper. E. SCHEIL AND K. E. SCHESSL. *Z. Naturforsch.*, **4a**, 524–6 (*Oct.*, 1949) *In German.*

This was investigated microscopically. The penetration depth was found to be $\propto$ time and the penetration velocity to be given by $dE/dt = A \exp(-Q/RT)$. For unannealed samples A changes for temps. between 600 and 900°K. Above 700° reduction of Cu₂O oxides takes place and surface diffusion, impeded at lower temps., was observed. At low temps. Bi atoms diffuse along grain edges at higher temps. on grain surfaces also, especially near the m.p. Twin boundaries form an exception.

E. P. WOHLFARTH

539.21

2703. Study of the sintering of glass. G. (KUCZYNSKI *J. Appl. Phys.*, **20**, 1160–3 (*Dec.*, 1949)

It has been shown experimentally that the mechanism of sintering of spherical glass particles is that of viscous flow. The viscosities of the investigated glass were determined for a range of temps. from 575°C to 744°C. These viscosities remain in good agreement with those obtained by other methods.

539.215.4 : 539.2

2704. Determination of crystallite size with the X-ray spectrometer. L. ALEXANDER AND H. P. KLUG. *J. Appl. Phys.*, **21**, 137–42 (*Feb.*, 1950).

The accuracy of the Scherrer crystallite size equation is limited in part by the uncertainty in β, the experimentally deduced pure diffraction broadening. Currently used procedures for estimating β from the observed breadth of a Debye–Scherrer line are not, in general, applicable to the X-ray spectrometer. By making use of a scheme of convolution analysis for analysing the effect of geometrical factors in broadening the pure diffraction contour [Abstr. 2490 (1950)], a correction curve is developed for determining β from the experimentally measured line breadths b and B (Jones's notation). The degree of reliability of this correction procedure is ascertained

applying Stokes's direct Fourier transform proce-
re for determining the form of the pure diffraction
ntour free of instrumental effects. Suggestive
ocedures are given for crystallite size determination
th the X-ray spectrometer in different size ranges,
d several examples are described. A.

539.215.6

05. Interference of growing spherical precipitate rticles. C. WERT AND C. ZENER. *J. Appl. Phys.*, , 5–8 (*Jan.*, 1950).

The exact theory of the rate of growth of spherical ecipitate particles has previously been developed r the initial stage where the individual precipitate rticles do not interfere with one another. In the esent paper this theory is carried one stage further include their mutual interference. It is found that the particular case of a very dilute solution this terference may be accounted for in a relatively mple manner. The applicability of the theory has en tested by new observations upon the precipita-on of C from α-Fe. Good agreement is found up 95% completion of precipitation. A.

539.23

706. The dependence of the structure of a [metallic] eposit on the number of local centres. E. TRAUB. . *angew. Phys.*, **1**, 545–9 (*Dec.*, 1949) *In German.*

A method is described by means of which the for-ation of thin Zn films is examined under various onditions. The effect of a preliminary condensation f an Ag substrate whose thickness (t) in terms of onatomic layers varied from 10^{-4} to 10^{+2} is investi-ated in detail, and measured by r = (calc.)/(meas.) esistance. r shows a max. for $t \simeq 0{\cdot}1$ Å, drops to a in. at $t \simeq 100$ Å, and then rises again. These bservations are interpreted. A diagram of the pparatus and graphs are given. R. A. WEALE

539.23

707. Thin films peeled from Teflon. C. K. JONES. etter in *J. Appl. Phys.*, **21**, 64–5 (*Jan.*, 1950).

539.23 : 537.311

708. Effect of adsorption of gases on the develop-ent [of the conductivity] of thin films. M. PERROT ND S. ARCAIX. *C.R. Acad. Sci., Paris*, **229**, 1139–42 *Nov.* 28, 1949) *In French.*

Thin films of Ag were evaporated on to glass plates nd their electrical resistance (R) measured at intervals rom the moment when evaporation stopped. The urve of R_0/R ($R_0 = 1$ MΩ) against time showed a ronounced max. during the first few min and then ell to a limiting value. The value of the max. epends on the thickness of the film. On the other and the reflecting power showed hardly any change ith time. R was also measured while gas was allowed o enter the vacuum chamber and the pressure hanged from 10^{-5} to 750 mm Hg and then back to 0^{-5} mm Hg. With dry air this cycle produced ractically no change but ordinary atmospheric air nd air saturated with water vapour caused R to ll and rise with the pressure. It is suggested that ven at 10^{-5} mm Hg adsorption of gas, especially ater vapour, plays a part in the ageing of these films. J. IBALL

539.231

2709. Properties of gold deposited at liquid air temperature. P. G. WILKINSON AND L. S. BIRKS. *J. Appl. Phys.*, **20**, 1168–71 (*Dec.*, 1949).

Gold deposited in vacuum at liquid air temp. contained defects and strain. The number of defects and their characteristic decay energy increased rapidly with increasing rate of deposit in the range from 1 to 5 micrograms/cm²/min. The defects decayed with rising temp. but the relief of strain did not occur until after most of the defects had disappeared. Electron micrographs showed that the gold film was made up of aggregations of discrete particles rather than a smooth continuous film. A.

539.234

2710. Particle size of evaporated gold. P. G. WILKINSON AND L. S. BIRKS. Letter in *J. Appl. Phys.*, **21**, 60 (*Jan.*, 1950).

539.24

2711. Determination of particle morphology from quantitative analyses. Z. W. WILCHINSKY. *Analyt. Chem.*, **21**, 1188–91 (*Oct.*, 1949).

A system of analyses is given for the determination of morphological features of powder particles. The method is applicable to particles composed of two or more phases distributed in such a way as to be characteristic of the particle structure. Deductions about particle morphology are made from the manner in which quantitative analyses for a chosen component vary with particle size. A.

539.26 : 537.531

X-ray line broadening in metals. *See Abstr.* 2492

539.26 : 545.824

Quantitative evaluation of X-ray patterns from mixed powders. *See Abstr.* 2760.

539.27

2712. Diffraction of electrons in graphite. J. HOERNI. Letter in *Nature, Lond.*, **164**, 1045–6 (*Dec.* 17, 1949).

Single crystals of graphite are examined in transmission, by a convergent beam of electrons. The "spots" on the resulting diffraction photographs are made up of bands, the different degrees of perturbation of which are stated to enable a differentiation to be made between *ababab . . .*, *ababcbcbc . . .* and *abababcabcabc . . .* stacking. J. THEWLIS

539.27

2713. An aluminum-beryllium alloy for substrate and replica preparations in electron microscopy. W. KAYE. *J. Appl. Phys.*, **20**, 1209–14 (*Dec.*, 1949).

539.27

2714. The use of spraying methods and of volatile suspending media in the preparation of specimens for electron microscopy. R. C. BACKUS AND R. C. WILLIAMS. *J. Appl. Phys.*, **21**, 11–15 (*Jan.*, 1950).

539.27

2715. A low temperature replica method for electron microscopy. C. E. HALL. Letter in *J. Appl. Phys.*, **21**, 61–2 (*Jan.*, 1950).

539.27

2716. Comments on the use of latex spheres as size standards in electron microscopy. C. H. GEROULD. Letter in *J. Appl. Phys.*, **21**, 183–4 (*Feb.*, 1950).

Seventeen independent determinations of size of

samples from the original batch [Abstr. 3485 (1949)] are reported which confirm the uniformity. Various precautions against variation are given.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

2717. Extension of Cauchy's relations to the coefficients of elasticity of the third order. A. HERPIN. *C.R. Acad. Sci., Paris,* **229,** 921–2 (*Nov.* 7, 1949) *In French.*

An expression involving powers of the deformations is given for the elastic potential energy of an isotropic solid. In the particular case where the Lamé coeffs. are equal and where the central forces have a potential, the constants of the expression can be calculated, and are found to be in reasonable agreement with earlier work. G. O. BAINES

539.31

2718. The elastic constants of a solid containing spherical holes. J. K. MACKENZIE. *Proc. Phys. Soc. Lond. B,* **63,** 1–11 (*Jan.*, 1950).

The effective bulk and shear moduli are calculated by a self-consistent method due to Fröhlich and Sack. The bulk modulus k is determined by applying a hydrostatic pressure, and the shear modulus μ by applying a simple homogeneous shear stress, to a large sphere. Each hole is surrounded by a spherical shell of real material, and the reaction of the rest of the material is estimated by replacing it by equivalent homogeneous material. For consistency, both the density and the displacement of the outer spherical boundary must be the same whether the hole and its surrounding shell are replaced by equivalent material or not. The effective elastic constants calculated from these conditions are

$$1/k = 1/k_0\rho + 3(1-\rho)/4\mu_0\rho + O[(1-\rho)^3],$$

$$(\mu_0 - \mu)/\mu_0 = 5(1-\rho)(3k_0 + 4\mu_0)/(9k_0 + 8\mu_0) + O[(1-\rho)^2],$$

where k_0 and μ_0 refer to the real material and ρ is the density of the actual material relative to that of the real material; in the next approximation k depends on the standard deviation of the volumes of the holes. The dilatation due to a distribution of pressures in the holes is $\bar{p}(1/k - 1/k_0)$, where $\bar{p}$ is the mean obtained when the pressure in each hole has a weight proportional to the volume of the hole. By using the hydrodynamic analogue of the elastic problem, the theory is briefly applied to the theory of sintering, and used to discuss the effective viscosity of a liquid containing small air bubbles. A.

539.312

2719. The response characteristics of linear systems. M. CINI. *J. Appl. Phys.,* **21,** 8–10 (*Jan.*, 1950).

For a linear system, steady-state response to sinusoidal stress cannot have a unique dynamic modulus and phase shift, but these quantities must be related to rate of creep; particularly they cannot be independent of external frequency. A proof is given that such linear system is always equivalent to a viscoelastic system. Finally the discrepancy betwee the relations deduced and experimental results various authors is pointed out and discussed.

539.31

2720. Residual stresses in simple distension. E. I ASSUR, N. N. DAVIDENKOV AND YU. S. TERMINASOV *J. Tech. Phys., USSR,* **19,** 1107–18 (*Oct.*, 1949) *Russian.*

539.31

2721. Relief of internal stresses by precipitation L. M. CLAREBROUGH. Letter in *Nature, Lond.*, **165** 39 (*Jan.* 7, 1950).

539.3

2722. Frictional loss in visco-elastic substances B. GROSS. Letter in *J. Appl. Phys.*, **21,** 185 (*Feb* 1950).

See Abstr. 2217 (1948).

539.37

2723. Large elastic deformations of isotrop materials. VI. Further results in the theory torsion, shear and flexure. R. S. RIVLIN. *Philo Trans. A* (*No.* 845) 173–95 (1949).

See Abstr. 1094–5, 3977 (1948), 3496 (1949).

539.37

2724. Deviations from Hooke's law and the limit of reversibility. A. KAMMERER AND A. LAMAR *C.R. Acad. Sci., Paris,* **229,** 1121–2 (*Nov.* 28, 1949 *In French.*

A theory based on a variable elastic modulu [Abstr. 5024 (1949)] explains the observed dependenc of the strength of a beam of plastic material i flexure on the rate of application of stress and on th shape of cross-section. J. G. OLDROY

539.37

2725. Some general relationships of the process elastoplastic deformations. I. I. GOLDENBLAT. *Dok Akad. Nauk, SSSR,* **68** (*No.* 6) 1005–8 (1949) *Russian.*

539.37

2726. Flow of a visco-plastic matter in the annula space between two co-axial tubes. P. K. SHCHIPANO *J. Tech. Phys., USSR,* **19,** 1211–14 (*Oct.*, 1949) *Russian.*

539.37

2727. The mechanism of deformation in metal with special reference to creep. W. A. WOOD AN W. A. RACHINGER. *J. Inst. Met.*, **17,** 237–53 (*Nov* 1949).

A study has been made of the changes in crystallin structure produced at various temps. when a metal subjected to the slow rate of strain typical of th creep process and also to the relatively rapid ra associated with ordinary mechanical testing. Measur ments were made at the same time of the strengt developed in the metal under the various condition of deformation. The object was to investigate th underlying mechanisms of deformation and in part cular the relation of deformation by creep to th more familiar deformation by slip. The results sho that the grains develop a substructure of a si determined by the temp. and rate of strain. Th mechanism of deformation changes from slip creep as the elements of the substructure exceed certain size. For a given rate of strain the size

ie elements in the substructure is larger the higher ie temp.; for a given temp. the elements are smaller ie more rapid the rate of strain. The strength and rain-hardening capacity of a metal decrease as the ibstructure becomes coarser, and on this observa- on an explanation of creep is based. A.

539.374

2728. The plastic behaviour of solids. A. McCance. *ngineering*, **168**, 570–4 (*Nov.* 25, 1949).

A theory is put forward of the changes in physical roperties caused by cold working, based on the ssumption that atoms can exist in two states: the ormal state of the annealed metal with a regular ittice, and the state of cold work with a distorted attice. The stress S in simple tension is related to ie contraction of area a by a formula $S = 2S_0\varepsilon^{-\alpha a}$ inh βa. Experimental results for many metals and on-metals are shown to support the theory, and alues of the constants S_0, α and β are deduced for ild steel, Cu, Al and Pb. A theory of creep is ased on a theory of diffusion of atoms in materials nder constant load. J. G. OLDROYD

539.374

2729. Plastic deformation of silver chloride. I. Photoelastic study of the internal stresses in glide ackets. J. F. Nye. *Proc. Roy. Soc. A*, **200**, 47–66 *Dec.* 22, 1949).

The pattern of birefringence caused by glide in AgCl is most clearly resolved when the glide planes re observed edge on. It is then possible to sketch he two orthogonal sets of curves giving the directions of polarization at each point of the pattern and, by means of a compensator, to find how the magnitude of the birefringence varies from point to point. The stress distribution can be deduced from the distribution of birefringence, provided that the important influence of the relative orientation of stress axes and crystal axes is taken into account. The state of stress in each plastically deformed grain can be resolved into two parts. (1) Each glide packet is subject to pure bending about two perp. axes lying in the glide plane (but with a neutral plane that is not always the middle plane of the packet). This gives stresses that vary discontinuously with a period equal to the spacing of the glide zones. (2) There is also a continuously varying stress distribution which changes only slightly in distances equal to the glide zone spacing. The curvature of the glide packets means either that all the dislocations in one glide zone have the same sign or that positive and negative dislocations are present there in unequal numbers. It is found that, throughout any one grain, the "dislocation charge" on each zone (to use an obvious electrical analogy) has the same sign and is never more than about twice the average for the grain. [See Abstr. 5707 (1949)]. A.

539.374 : 538.245

Influence of plastic deformations on the temperature relation of the coercive forces. *See Abstr.* 2582

539.374 : 548.2

2730. Erratum: The plastic deformation and crystal orientation of thallium halides. A. Smakula and M. W. Klein. *J. Opt. Soc. Amer.*, **39**, 890 (*Oct.*, 1949). See Abstr. 5029 (1949).

539.378.3

2731. The role of the superficial mobility of metal atoms in the preparation of deposited contacts. A. B. Shekhter, A. I. Echeistova and I. I. Tretyakov. *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 6) 1069–73 (1949) *In Russian.*

539.389.4

2732. Tentative explanation of hysteresis phenomenon in tension for an elastic polymer which crystallizes. J. Clouaire. *J. Phys. Radium*, **10**, 295–300 (*Oct.*, 1949) *In French.*

In addition to internal friction, two constants are introduced which represent the relative contribution of entropy and internal energy changes to the elasticity of the amorphous material (α) and the proportion of the material (β) which crystallizes. The latter is dependent on the past strain history of the material. These are used to interpret hysteresis obtained by repeated testing at elongations up to 700% extension. J. E. CAFFYN

539.4

2733. High strength ceramics for high temperature use. Letter in *J. Appl. Phys.*, **21**, 65 (*Jan.*, 1950).

539.4

2734. A dimensional analysis of metal cutting. D. C. Drucker and H. Ekstein. *J. Appl. Phys.*, **21**, 104–7 (*Feb.*, 1950).

539.42

2735. Energy partition in isothermal fracture. M. M. Rogers and F. T. Rogers, Jr. Letter in *J. Appl. Phys.*, **21**, 60–1 (*Jan.*, 1950).

539.501

2736. Report on the principles of rheological nomenclature. J. M. Burgers and G. W. Scott Blair. *Proc. 1st Int. Congr. Rheol., Scheveningen*, 1948 (*Sect. V*) 70 *pp.* (1949).

539.501

2737. Views on rheology. L. Prandtl. *Phys. Bl.*, **5** (*No.* 4) 161–72 (1949) *In German.*

The principal items considered in the present review are creep, relaxation, the effect of rate of loading, hysteresis and the effect of temp. fluctuations, much of the treatment being based on a simple one-dimensional model. The properties of liquids and saturated soils are briefly considered. The main object of the review is to bring together the various different viewpoints. A. C. WHIFFIN

539.501

2738. The influence of the nature of the dispersion medium on the rheological properties of a deposit of quartz powder. V. Romanovsky. *C.R. Acad. Sci., Paris*, **229**, 871–2 (*Nov.* 2, 1949) *In French.*

Deposits from quartz suspensions show yield values which decrease with increasing concentration of NaCl in the dispersion medium. Suggested that it is an electrostatic effect of the NaCl on the water absorption of the quartz. J. E. CAFFYN

539.501

2739. Rheological measurements and adhesion. J. F. T. Blott and W. B. Bonnor. Letter in *Nature, Lond.*, **164**, 799 (*Nov.* 5, 1949).

When tangential shear tests were made on lubri-

cating grease, at shearing stresses exceeding the so-called "first yield stress" flow of grease occurred by slip on the thin film of oil at the grease/solid interface. At a higher stress, called the "second yield stress," flow occurred as a result of breakdown of the bulk grease structure. Shear in the main structure occurs so far from the interface that adhesion forces can play little part, but, assuming that the first yield is due to a rigid structure being formed in the slip film of oil under the influence of adsorption forces, its magnitude might depend on the chemical nature of the solid surface. Adsorption forces may also affect the thickness of the oil film. It would be expected that the nature of the solid surface would affect the flow of grease at stresses intermediate between the first and second yield values, and this is supported by Mardles's experiments. A. C. WHIFFIN

539.53

2740. Interferometric examination of hardness indentations on tin. S. TOLANSKY AND D. G. NICKOLS. *Nature, Lond.*, **164**, 840 (*Nov.* 12, 1949).

Vickers's diamond pyramid indentations on Sn crystallites are examined by multiple-beam interferometry. A striking asymmetry appears in the associated surface distortions. The material piles up in two directions and at right angles, sinks in. The square indentation is correspondingly distorted. The effect is crystallographic and independent of the orientation of the square. S. TOLANSKY

539.531

2741. Application of a method of measuring the hardness of microscopically small volumes of matter to the solution of certain problems in physics. B. S. IOFFE. *J. Tech. Phys., USSR*, **19**, 1089–102 (*Oct.*, 1949) *In Russian.*

The most effective method is shown to be by pressure with a pyramidal form of agent. The extent to which load governs the degree of hardness found is not yet clear. Other factors, such as the dimensions, especially the depth, of the indentation, as well as the properties of the superficial metallic layer indented, come into play. In examining the latter it was found that residual stresses, for some still unexplained reason, decreased rather than increased with the size of the deformation. Results are shown graphically for Al, Pb, Cu and β-brass. In all cases hardness diminished with the reduction of indentation depth. After noticing the practical applications of such measurement to glueing, crushing, grinding polishing, etc., and its use in metallography, the studi of residual stress and electrical and X-ray analysis the article considers the distribution of hardnes within a single crystal (cast electrolytic Cu and ferriti crystals are illustrated) showing the influence of bot physical and mechanical attributes. Profitable line of future research on the subject are indicated.

J. CLEUGH

539.5

2742. Grain boundary relaxation and the mechanism of embrittlement of copper by bismuth. T.-S. KÉ *J. Appl. Phys.*, **20**, 1226–31 (*Dec.*, 1949).

539.8

2743. Volume changes in the plastic stages of simpl compression. P. W. BRIDGMAN. *J. Appl. Phys.*, **20** 1241–51 (*Dec.*, 1949).

A method has been devised by which the volum changes occurring during plastic flow in simple com pression are directly measured in a dilatometer durin the flow process. The great superiority of such direct determination over an indirect determinatio from the alteration of dimensions is pointed out Results are obtained for 3 rocks, quartz crystal, and number of metals, including several grades of stee and Fe. The volume change during plastic flow i not equal to the product of mean hydrostatic stres into the ordinary compressibility in the elastic range but may vary in a much more complicated way There are in the first place permanent changes o volume retained after release of stress; these have lon been known and may be of either sign. In additio to the permanently retained changes there may b changes of volume during the action of stress whic may be notably > the permanently retained par and which also may be of either sign. The mos striking of these is a component of volume increas under increasing compressive stress which in th upper range of stress near the fracture point may b > the normal component of volume decrease, so tha the total volume change is retrograde. This com ponent is recoverable and reversible on release o stress. It would appear, therefore, that in at leas some cases the irreversible phenomenon of fracture i prepared for in the region immediately below th stress of fracture by the appearance of a reversibl change of volume of sign the opposite of that due t the elastic action of the stresses. A

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.122

2744. The equilibrium $H_2 + HDO \rightleftharpoons HD + H_2O$, and the further exchange equilibrium in the system H_2, D_2, and H_2O. H. E. SUESS. *Z. Naturforsch.*, **4a**, 328–52 (*Aug.*, 1949) *In German.*

The distribution constant of D_2 between H_2 and H_2O is independent of the concentration. Th equilibrium constants of the reactions $H_2 + HDO \rightleftharpoons HD + H_2O$ and $HD + D_2O \rightleftharpoons D_2 + HDO$ diffe by < 3%. The equilibrium constant,

$$K = [H_2][HDO]/[HD][H_2O] = [HD][D_2O]/[D_2][HDO]$$

follows the equation $\log K = 928/4{\cdot}57T - 0{\cdot}1320$.

A. J. ME

541.124

45. On the non-equilibrium theory of absolute ction rates. H. M. HULBURT AND J. O. HIRSCH-DER. *J. Chem. Phys.*, **17**, 964–8 (*Oct.*, 1949).

The ensemble of point masses representing reaction mplexes in configuration space is treated as an ideal s by methods of exact kinetic theory. Hydro-namic equations for the mean motion of the semble are derived. The theory of compressible w is used to show that under a very wide range of nditions, the energy distribution characteristic of e reactants in a chemical reaction is maintained in e reaction complex at least until it passes through e activated state. A.

541.124

46. Two radioactive methods for studying certain s-metal reactions. C. K. BECK. *Science*, **110**, 371–2 *Oct.* 7, 1949).

The types of reaction which can be studied by the ethods described are those in which the reacting s contains a radioactive component, one product the reaction is a solid which adheres more or less mly to the metal surface, and the radioactive com-onent of the gas becomes a component of the solid action product. A typical reaction is that between seous ruthenium pentafluoride and a clean metal rface such as Cu. In one method the metal con-rned is made into a Geiger counter. The radioactive s is admitted for a given time and is then pumped t. After purging with inert gas and filling with a itable counting gas, the amount of deposited non-latile product is determined by the counting rate. the second method the metal is made into fine wire d is exposed to the action of the radioactive gas. rom time to time short pieces of the wire are removed samples, and are mounted in succession along the xis of a suitably designed counter, where they serve oth as the source of radioactivity being measured nd the collecting electrode. The advantages and isadvantages of each method are outlined.

A. J. MEE

541.124 : 530.145

47. Erratum: The quantum mechanics of chemical inetics of homogeneous gas phase reactions. II. pproximations for displacement reaction between an om and a diatomic molecule. S. GOLDEN AND . M. PEISER. *J. Chem. Phys.*, **17**, 842 (*Sept.*, 1949).

See Abstr. 6487 (1949).

541.126 : 536.461

48. The theory of flame propagation. J. O. IRSCHFELDER AND C. F. CURTISS. *J. Chem. Phys.*, **7**, 1076–81 (*Nov.*, 1949).

541.127

49. The effect on reaction rates caused by the bstitution of C^{14} for C^{12}. I. The alkaline hydrolysis carboxyl-labeled ethyl benzoate. W. H. STEVENS ND R. W. ATTREE. *Canad. J. Res. B*, **27**, 807–12 *Oct.*, 1949).

The substitution of C^{14} for C^{12} changes the rate of drolysis of the ester. Ester molecules containing ^{14} hydrolyse at a slower rate than normal ester olecules. The ratio of the hydrolysis rate constants room temp. was found to be $0{\cdot}86 \pm 0{\cdot}016$. A.

ELECTROCHEMISTRY 541.13

541.133.08

2750. Application of the Miller effect for compensation of dephasing in a conductivity bridge. J. VERGNOLLE. *C.R. Acad. Sci., Paris*, **229**, 831–2 (*Oct.* 24, 1949) *In French.*

A valve arrangement with diagram is described, equivalent to a condenser whose capacity is capable of continuous variation within wide limits, whereby the necessary compensation during the measurement of conductivity by use of a bridge method with alternating currents may be effected. H. H. HODGSON

541.135

2751. Macroscopic space charge in electrolytes during electrolysis. C. A. REED AND W. SCHRIEVER. *J. Chem. Phys.*, **17**, 935–44 (*Oct.*, 1949).

An apparatus and procedures were developed which made possible reproducible data on potential distribution in an electrolyte. In a uniform column of electrolyte the potential rise was found to be a non-linear function of the distance from the cathode, and it was shown that this non-linearity must have been due to macroscopic space charges in the electrolyte. Calculations showed the space charge to be positive very close to the cathode, negative in the next $\frac{1}{4}$ of the column, positive for the next nearly $\frac{3}{4}$ of the column and negative very close to the anode. A.

541.135.5

2752. Anodic behaviour of iron in sulphuric acid. U. F. FRANCK. *Z. Naturforsch.*, **4a**, 378–91 (*Aug.*, 1949) *In German.*

The electrochemical processes occurring in the anodic passivation of Fe, and in its subsequent activation in H_2SO_4 have been investigated, and the results are considered in connection with the Ostwald–Lillie nerve model. The dependence of passivity time on anodic c.d. and on the electrolyte streaming was determined. The Fe rendered passive in this way behaves in the same manner as that made passive by immersion in HNO_3 as far as the nerve model is concerned. The dependence of activation time on cathodic c.d. follows the same equation as that given by Blair on the basis of determinations with living nerves. A. J. MEE

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14

541.14

2753. Flash photolysis and spectroscopy. A new method for the study of free radical reactions. G. PORTER. *Proc. Roy. Soc. A*, **200**, 284–300 (*Jan.* 6, 1950).

A technique of flash photolysis and spectroscopy has been developed, using gas-filled flash discharge tubes of very high power. The properties of these lamps as spectroscopic and photochemical sources have been studied and details are given of their construction, spectra, duration of flash, and luminous efficiency in the photochemically useful region. An apparatus is described which produces a very great photochemical change, in some cases over 80%, in

1/1 000 sec and in a gas at several cm pressure contained in an absorption tube 1 m long, and which photographs the absorption spectrum at high resolution in 1/20 000 sec at short intervals afterwards. Examples of the rapidly changing spectra of substances undergoing reaction, including the spectra of some of the intermediate radicals involved, are shown. A.

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.182.025

2754. Thixotropy in high molecular substances. F. H. MÜLLER. *Kolloid Z.*, **112**, 1–6 (1949) *In German.*

Observation has shown that certain high-polymer substances, through simple mechanical deformation, pass from a horny, stiff state to a soft rubbery condition, and then slowly revert to their former hardness. This effect was referred to as high-polymer thixotropy, owing to its similarity to the usual phenomena of liquids and gels. RUBBER RESEARCH ASSOCIATION

541.183

2755. A few remarks on physical adsorption. C. J. GORTER AND H. P. R. FREDERIKSE. *Physica*, **15**, 891–6 (*Oct.*, 1949).

Remarks are made about the thermodynamical, kinetical and statistical treatment of physical adsorption with special reference to the entropy of the adsorbed matter. A.

541.183

2756. Phase transitions in boundary films. W. HIRST AND G. P. ORLEANS. Letter in *Nature, Lond.*, **165**, 797–8 (*Nov.* 5, 1949).

Experiments have been carried out to study the relation between the expansion of an adsorbent and temp. when the available surface of the adsorbent is covered by an adsorbed monomolecular layer. Rods of sintered alumina and of cupric oxide were soaked in solutions of fatty acids and of various stearates and the film-covered rods heated in an extensometer. The extension-temp. curve showed a discontinuity in each case which appears to represent the m.p. of the film. A similar discontinuity was observed when the alumina rods were heated in contact with the bulk solution of adsorbate. For soaps, esters and acids which do not react with the adsorbent there is little difference between the bulk m.p. and that of the monomolecular film for the longer chain molecules, but as the chain length decreases the film m.p. becomes progressively lower than the bulk m.p. The presence of solvent always lowers the m.p. J. IBALL

541.183.2

2757. Moisture permeability, diffusion and sorption in organic films. I. Experimental investigation. D. L. LEVI AND A. M. THOMAS. *Rep. Brit. Elect. Res. Ass.* (*Ref. A/T*103) 1–17 (1948).

Measurements have been made of the permeability, sorption and diffusion constants of water vapour in films of polythene, polyvinyl chloride, cellulose acetate, polymethyl methacrylate, linseed oil and two insulating baking varnishes. The constants generally show an exponential variation with temp. The time rates of sorption and desorption at moderate a low humidities show the logarithmic variati expected on the assumption that Fick's law applicable to diffusion within the film; on the oth hand, at high humidities, desorption takes pla more rapidly than sorption which tends to devia more from the logarithmic variation. The variati of sorption with humidity at constant temp. has be determined for two of the materials, viz. an insulati varnish and a film of polyvinyl chloride. Bo materials show an increase of sorption constant w humidity, and thus fail to obey Henry's law, but t deviations for the former material are not large a occur only at relative humidities above 75%, but t the latter material the deviations are very large, t sorption constant increasing by a factor of 5 fon change of relative humidity of 50% to 96%. result of importance is that the curve of mass moisture sorbed per unit weight of film when plott as a function of relative humidity for a given tem also passes through points for the moisture sorbed other temps. for the same relative humidity, i.e. sor tion as a function of relative humidity is independd of temp. (the range so far investigated being 25° 40°c). In spite of deviations from Henry's law, t variation of permeability constant with relat humidity is small even with polyvinyl chloride, t polythene shows a decreasing permeability at hi humidities.

541.18

2758. Condensation coefficient and adsorptio H. M. CASSEL. *J. Chem. Phys.*, **17**, 1000–1 (*Oc* 1949).

The condensation coeff. α [(= observed rate evaporation)/(excess number of molecules striking t surface per unit time)] results from at least two ste (*a*) adsorption, (*b*) transition from adsorbed film in substrate. Applying the Langmuir isotherm to (*a*) a Wyllie's expression [Abstr. 3808 (1949)] to (*b*) expression for α of liquids is obtained. At temp $< 0{\cdot}5$ of the critical temp. in bulk, the cohesive forc between the adatoms will reduce α. In cryst matters are complicated by the fact that substrate-fi transitions can occur only at certain active centres S. J. GRE

CHEMICAL STRUCTURE 541.4/.6

541

2759. Studies of the hydrogen bond. III. Molecu orbital treatment of some saturated and unsatura ethers. I. FISCHER. *Ark. Fys.*, **1**, *Paper* 23, 495–5 (1949).

CHEMICAL ANALYSIS 543/545

545.824 : 539

2760. Method for the quantitative evaluation X-ray patterns from mixed powders. J. C. BRENTANO. *J. Appl. Phys.*, **20**, 1215–22 (*Dec.*, 194

The quantitative evaluation of the constituents

xtures from X-ray powder diffraction patterns has en highly successful in certain cases, but has been nd subjected to limitations as an analytical tool of re general use. These arise from a number of ects which interfere with a simple interpretation the patterns. The paper discusses the basic aspects these interferences, in particular of those which result from superpositions of lines, and develops a method which takes account of them. The method is adapted to meet such cases where the constituents or impurities which interfere with the regular patterns are unknown. A.

545.82 : 535.375.5

Raman spectra as analytical aids. *See Abstr.* 2367

CRYSTALLOGRAPHY 548

548.0 : 537.226.2

61. Dielectric constants and polarizabilities of ns in simple crystals and barium titanate. S. OBERTS. *Phys. Rev.*, **76**, 1215–20 (*Oct.* 15, 1949).

The observed permittivities K of alkali halides and rtain other types of crystals coincide with a relatively mple interpretation of dielectric polarization which based on the classical equation of Clausius and osotti. The polarizability of each elementary ion s only a small positive temp. coeff. and is invariant hen the given ion is incorporated in different ystalline solids subject to certain symmetry require- ents. The polarizabilities of the ions in cubic $BaTiO_3$, although normal, account quite satisfactorily r the high observed values of K. A method of timating K's from the known polarizabilities of ns is applied to several compounds for which electric data have not been reported. A.

548.0 : 537.312

62. KCl crystals with added alkaline earth lorides. H. KELTING AND H. WITT. *Z. Phys.*, **126** *Nos* 7–9) 697–710 (1949) *In German.*

Preparation of KCl crystals containing known roportions of alkaline earth chlorides is described. he bivalent ions increase the conductivity of the Cl, and cannot be extracted from the crystals by an ectric field. At the m.p., they contribute approxi- ately the same amount to the conductivity of the ystals as each mono-valent ion contributes to that the melt. Other electrical properties are also escribed. C. B. ALLSOPP

548.5

63. Action of a magnetic field on the crystallization d tartaric acid. J. BLANDIN. *C.R. Acad. Sci., aris*, **229**, 1075–7 (*Nov.* 21, 1949) *In French.*

548.52

64. Grain growth in octachloropropane. W. C. ICCRONE AND P. T. CHENG. *J. Appl. Phys.*, **20**, 30–1 (*Feb.*, 1949).

548.52

65. Comments on "Grain growth in octo- loropropane." P. A. BECK. *J. Appl. Phys.*, **20**, 231 *Feb.*, 1949).

See Abstr. 2764 (1950).

548.57 : 537.581

Thermionic work function of the (100) face of a ngsten single crystal. *See Abstr.* 2528

548.524

66. Orientation of single-crystal rods of copper own from the melt. A. A. PETRAUSKAS AND F. AUDRY. Letter in *J. Appl. Phys.*, **20**, 1257 (*Dec.*, 49).

Single crystal rods $\frac{3}{8}$ in diameter and 5 in long were grown in graphite crucibles in an atmosphere of dry N, using Bridgman's technique [*Proc. Am. Acad.*, **60**, 305 (1925)]. Crystals of given orientation were obtained by placing a single crystal seed with the desired orientation at the bottom of the crucible. J. A. FRANKS

548.53

2767. Strain induced grain boundary migration in high purity aluminum. P. A. BECK AND P. R. SPERRY. *J. Appl. Phys.*, **21**, 150–2 (*Feb.*, 1950).

A method has been developed which allows positive determination of the direction of grain boundary movements. It was confirmed that migration resulting from surface energy takes place in the direction toward the centres of curvature of the boundaries. Strain induced migration, such as occurs in recrystallization, proceeds in a direction away from the centres of curvature of the moving boundaries. Certain strained grains serve as nuclei for strain-free grains of the same orientation which grow at the expense of neighbouring strained grains. Most of the strain-free grains formed during the annealing of high purity Al cold rolled up to about 40% are produced by this mechanism without the formation of new nuclei. A.

548.582

2768. Surface wandering of wolfram [tungsten] on its own crystal lattice. E. W. MÜLLER. *Z. Phys.*, **126** (*Nos* 7–9) 642–65 (1949) *In German.*

The field-emission from a fine W point (produced by etching a wire in $NaNO_2$) was observed by means of a fluorescent coating on the interior of the vacuum flask. The point could be maintained at various temps. by passing a current through the wire and a subsidiary wire attached to it at the point where the taper began. After heating at 1 200°K or higher the emission pattern showed that the tip was practically a hemisphere, with only traces of 011, 112 and 001 faces. The radius of curvature (known from the potential difference required to produce emission) increased with time of heating, the measurable range being about 1 500 to 5 400 Å. From the rate of change of radius it was deduced that the number of atoms wandering away per cm^2 per sec is given by $A \exp(-B/RT)$, where $A = 5 \times 10^{24}\ cm^{-2}\ sec^{-1}$ and $B = 106\,500$ cal. In the range investigated (1 850–2 700°K) evaporation is negligible compared with wandering; they would become approximately equal at the melting point. The hemispherical form is found only during the rounding off of a point. If the tip is built up by condensation of W evaporated from a nearby filament the emission pattern shows the usual faces and edges of a single crystal; these can be

rounded off in turn by surface wandering. The measurements are interpreted in accordance with the Stranski–Suhrmann theory [Abstr. 1575 (1948)].

A. J. C. WILSON

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

2769. Orientation-translation waves in molecular crystals. II. Dynamics of two and three dimensional lattices. N. N. Porfiréva. *J. Exp. Theor. Phys., USSR*, **19**, 692–702 (*Aug.*, 1949) *In Russian.*

A previous analysis of the propagation of oscillations in a 1-dimensional lattice of a molecular crystal [Abstr. 5113 (1949)] is extended to 2 and 3 dimensions. It is shown under what conditions translational and orientational oscillations can exist independently. Limiting frequencies are found and the character of the motions of the molecules in the elementary cell at these frequencies is described.

A. L. MACKAY

548.7

2770. Some possible characteristics of the dynamics of molecular crystal lattices. Sh. Sh. Raskin, A. V. Sechkarev and F. I. Skripov. *Dokl. Akad. Nauk, SSSR*, **66** (*No.* 5) 837–40 (1949) *In Russian.*

Following earlier work [Sh. Sh. Raskin, Abstr. 6921 (1949)] the dynamics of a row of molecules is treated. There may be 1 or 2 molecules per unit cell each with 2 translational and 1 rotational degrees of freedom. Expressions for the energy of interaction of a molecule with its neighbours and for the limiting frequencies are obtained. It is found that the symmetry, in particular when the molecules are at centres of inversion, may determine the distribution of oscillations between pure translation and pure rotation. Skripov has extended this conclusion to 3 dimensions [following Abstr.]. The authors suggest that in many real crystals the degree of coupling between translational and rotational modes is small, even if symmetry does not impose strict limitations.

A. L. MACKAY

548.7

2771. The influence of crystal symmetry on the character of the limiting vibrations of a molecular lattice. F. Skripov. *Dokl. Akad. Nauk, SSSR*, **66** (*No.* 6) 1075–7 (1949) *In Russian.*

Extension of previous Abstr. The distribution of oscillations between translational and rotational modes in the scattering spectra of molecular crystals is examined theoretically. The potential energy, near the limiting frequencies, of a 3-dimensional lattice is expressed as a function of the translational and angular displacements of the molecules in an elementary cell. Only the case in which molecules are located at centres of inversion is considered and it is found that only purely translational or purely rotational, but not mixed (translation-rotation), oscillations exist at the limiting frequencies. An alternative treatment using normal co-ordinates is discussed.

A. L. MACKAY

548

2722. Crystal statistics. II. Partition functi evaluated by spinor analysis. B. Kaufman. *Ph Rev.*, **76**, 1232–43 (*Oct.* 15, 1949).

The partition function for a 2-dimensional bina lattice is evaluated in terms of the eigenvalues of t 2^n-dimensional matrix **V** characteristic for the latti Use is made of the properties of the 2^n-dimensio "spin"-representation of the group of rotations $2n$-dimensions. In consequence of these properti it is shown that the eigenvalues of **V** are known soon as one knows the angles of the $2n$-dimensio rotation represented by **V**. Together with the eige values of **V**, the matrix Ψ which diagonalizes **V** obtained as a spin-representation of a known rotatic The determination of Ψ is needed for the calculati of the degree of order. The approximation, which all the eigenvalues of **V** but the largest a neglected, is discussed, and it is shown that the exa partition function does not differ much from t approximate result.

548

2773. Crystal statistics. III. Short-range order a binary ising lattice. B. Kaufman and L. Onsage *Phys. Rev.*, **76**, 1244–52 (*Oct.* 15, 1949).

The degree of order in a binary lattice is describ in terms of a family of "correlation" functions. T correlation function for two given lattice sites stat what is the probability that the spins of the two sit are the same; this probability is, of course, a functi of temp., as well as of the distance and orientation the atoms in the pair. It is shown that each correl tion function is given by the trace of a correspondi 2^n-dimensional matrix. The trace is found by spin analysis in terms of certain functions of temp., Σ and these are then calculated with the aid of an ellip substitution. Correlations for the 5 shortest distanc (without restriction as to the orientation of the pa within the plane) are plotted as functions of tem In addition, the correlation for sites lying within t same row is given to any distance. For the critic temp. this correlation is plotted as a function distance. It is shown that the correlation tends zero as the distance increases, that is to say: there no long-range order at the critical temp.

548.7

2774. A low temperature single crystal X-r diffraction technique. H. S. Kaufman and Fankuchen. *Rev. Sci. Instrum.*, **20**, 733–4 (*Oc* 1949).

A low temp. X-ray diffraction technique, especial suitable to single crystal work, is described. Cryst are grown in glass capillaries on the X-ray came Position and orientation are determined with the a of a polarizing microscope on the apparatus. special specimen holder is used which prever moisture condensation and permits rotation a oscillation of the specimen while it is being cooled.

548.7

2775. Effective use of collimating apertures small-angle X-ray diffraction cameras. O. E. Bolduan and R. S. Bear. *J. Appl. Phys.*, **20**, 983– (*Oct.*, 1949).

548.733

6. Note on the accuracy of the Buerger precession era. H. T. EVANS, JR. Letter in *Rev. Sci. rum.*, **20**, 751 (*Oct.*, 1949).

548.733 : 536.413.2

7. A high temperature precision X-ray camera. ne measurements of the thermal coefficients of ansion of beryllium. P. GORDON. *J. Appl. Phys.*, 908–17 (*Oct.*, 1949).

he camera is a modification of the back-reflection metrical focusing type. The camera, specimen furnace are used within a vacuum chamber to id oxidation. The apparatus in its present form been employed at temps. up to 1 000°C, but her temps. could be easily attained by making a minor changes in the furnace materials. The ice parameters of Be have been measured up to 00°C. The derived coeffs. of thermal expansion, h linear and bulk, are presented as a function of np. In addition, the data present strong evidence t the hexagonal close-packed form of Be which sts at room temp. is stable up to at least 1 000°C, ntrary to several reports in the literature. A.

548.734

78. The application of X-ray methods to the ermination of phase boundaries in metallurgical uilibrium diagrams. E. A. OWEN AND D. P. MORRIS. *Inst. Met.*, **17**, 145–68 (*Oct.*, 1949).

Recent criticisms of the X-ray powder method of ermining phase boundaries in metallurgical uilibrium diagrams [notably by Hume-Rothery d Raynor, Abstr. 1307 (1941)] are considered in tail and are shown to be unfounded. Certain jections to the microscopical method are pointed t, and in the light of X-ray investigations carried t on solid specimens, it is concluded that in general e study of equilibrium conditions is best conducted th material in powder form. A.

548.734.3.036

79. Punched card code for X-ray diffraction wder data. F. W. MATHEWS. *Analyt. Chem.*, **21**, 72–5 (*Oct.*, 1949).

Punched and slotted cards of a simple type, needing elaborate machinery, may be used for facilitating e identification of materials by means of their X-ray wder diagrams. A. J. C. WILSON

548.734.8

80. Detection of centres of symmetry by an X-ray ethod. E. R. HOWELLS, D. C. PHILLIPS AND D. ROGERS. *Research, Lond.*, **2**, 338–9 (*July*, 1949).

The theoretical intensity distribution functions for ray reflections [Abstr. 6562 (1949)] are verified for e centrosymmetric 010 zone and the non-centrosymmetric 100 zone of *m*-tolidene dihydrochloride. is found that the fraction of reflections with intensity $z\%$ of the average is a convenient test for centrosymmetry, being $1 - \exp(-z)$ for non-centrosymmetric zones or crystals and $\mathrm{erf}(z/2)^{\frac{1}{2}}$ for ntrosymmetric. A. J. C. WILSON

548.734.8

81. Determination of space groups by intensity tistics. D. ROGERS. Letter in *Research, Lond.*, 342–3 (*July*, 1949).

The 121 diffraction symbols [Buerger, *X-Ray Crystallography*, New York (1942)] are increased to 215 if the statistical tests for centrosymmetry [Abstr. 6562 (1949)] can be applied. It is proposed that a zone or row with a centrosymmetric intensity distribution be called centric. All 32 crystal classes and 200 of the space groups become distinguishable by X-ray diffraction. The remaining 30 space groups include the 11 pairs of enantiomorphs and 8 non-enantiomorphic pairs I222, $I2_12_12_1$; I23, $I2_13$; C31m, C3m1; $C\bar{3}1m$, $C\bar{3}ml$. A suitable notation is to underline the appropriate letter or number in the Buerger diffraction symbol for centrosymmetric cells or centric zones, and to place a circumflex over the appropriate symbol for centric rows.

A. J. C. WILSON

548.735 : 539.26

2782. X-ray measurement of order in single crystals of Cu_3Au. J. M. COWLEY. *J. Appl. Phys.*, **21**, 24–30 (*Jan.*, 1950).

X-ray diffraction methods have been used to measure long- and short-range order parameters for single crystals of the alloy Cu_3Au held at elevated temperatures. It is shown that short-range order parameters may be obtained by a 3-dimensional Fourier analysis of the "scattering power" for the diffuse background scattering of X-rays, expressed as a function of reciprocal lattice co-ordinates. Appropriate experimental and computational procedures are outlined. Intensity measurements have been made with a special arrangement of a bent-crystal monochromator and a Geiger-counter spectrometer. Short-range parameters are given for the first 10 shells of atoms surrounding a given atom for 3 temperatures above the critical temperature of Cu_3Au. These results, and those for the long-range order parameter, agree well with theoretical predictions. A.

548.735.42

2783. A general powder X-ray photography. T. ITO. Letter in *Nature, Lond.*, **164**, 755–6 (*Oct.* 29, 1949).

A trial-and-error method for indexing powder photographs is described. 3 reflections are arbitrarily chosen as 100, 010, 001, giving (triclinic) reciprocal axes a^*, b^*, c^*. $Q' = h^2a^{*2} + l^2c^{*2}$ is then plotted as a function of l^2 for various values of h^2; the observed values of $Q \equiv 4\sin^2\theta/\lambda^2$ for the pairs of reflections $h0l$ and $h0\bar{l}$ will lie at equal distances ($2lhc^*a^*\cos\beta^*$) above and below these lines, thus determining β^*. Similarly α^* and γ^* are found. If no success is obtained with the first choice of a^*, b^*, c^*, further trials are made until all the lines can be indexed; a cell with the true symmetry can then be picked out. A. J. C. WILSON

548.735.7

2784. X-ray line-breadths of martensite. M. A. JASWON; J. MAZUR. Letter in *Nature, Lond.*, **164**, 712–13 (*Oct.* 22, 1949).

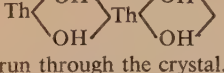
Discuss the effects of particle size and internal stress on line-breadths. A. E. DE BARR

548.736.5

2785. The crystal structure of $Th(OH)_2CrO_4 . H_2O$. The $Th(OH)_2$ chain, a new structure element. G. LUNDGREN AND L. G. SILLÉN. *Naturwissenschaften*, **36** (*No.* 11) 345–6 (1949) *In German.*

Monoclinic, space group $P2_1/m$, $a = 7{\cdot}66_2$, $b =$

$6\cdot10_1$, $\mathring{c} = 6\cdot926 \pm 0\cdot01$ kX, $Z = 2$. From Patterson projections the Th and Cr atoms were found to lie in 2(*e*) with parameters $x = 0\cdot183$, $z = 0\cdot113 \pm 0\cdot005$; $x = 0\cdot47$, $z = 0\cdot72 \pm 0\cdot02$ respectively. The O atoms were fixed by packing considerations and the known shape of the CrO_4 group. Zigzag chains of



were found to run through the crystal.

A. J. C. WILSON

548.736.5

2786. The crystal structure of ammonium tetrametaphosphate. J. A. A. KETELAAR AND C. H. MACGILLAVRY. Letter in *Nature, Lond.* **164**, 960–1 (*Dec.* 3, 1949).

548.736.5

2787. The structure of vivianite and symplesite. H. MORI AND T. ITO. *Acta Cryst.*, **3** (*No.* 1) 1–6 (1950).

548.737

2788. Identification and crystallography of penicillin and related compounds by X-ray diffraction methods. G. L. CLARK, W. I. KAYE, K. J. PIPENBERG AND N. C. SCHIELTZ. *The Chemistry of Penicillin, Princeton University Press* (1949) 367–81.

Powder patterns are given for over 50 substances, some of uncertain composition, and the unit cell and space groups of about 10. A. J. C. WILSON

548.737

2789. The X-ray crystallographic investigation of the structure of penicillin. D. CROWFOOT, C. W. BUNN, B. W. ROGERS-LOW AND A. TURNER-JONES. *The Chemistry of Penicillin, Princeton University Press* (1949) 310–66 + 1.

The analysis proceeded by correlation of the isomorphous K and Rb benzylpenicillins and the related but non-isomorphous Na salt. A few signs could be determined from Rb—K, leading to rough Fourier syntheses. Trial and error with the "fly's eye" led to a rough synthesis for the Na salt, and intercomparison of the Rb and Na synthesis suggested that the "β-lactam" structure was more probable than the previously assumed "oxazolone." With approximate co-ordinates fixed by the projections it was possible to undertake 3-dimensional syntheses, and the β-lactam structure was established purely on physical grounds. Space groups and unit cells are given for the Na salt ($P2_1$, $a = 8\cdot48$, $b = 6\cdot33$, $c = 15\cdot63$, $\beta = 94\cdot2°$, $Z = 2$), the K salt ($P2_12_12_1$, $a = 9\cdot36$, $b = 6\cdot37$, $c = 30\cdot35$, $Z = 4$), the Rb salt ($P2_12_12_1$, $a = 9\cdot45$, $b = 6\cdot44$, $c = 30\cdot2$, $Z = 4$), and about 30 other compounds related to or degraded from penicillin. A. J. C. WILSON

548.737

2790. Crystal structure of the hydrate form of racemic acid. G. S. PARRY. Letter in *Nature, Lond.*, **164**, 885–6 (*Nov.* 19, 1949).

548.737

2791. Crystal structure of Ovalene. D. M. DONALDSON AND J. M. ROBERTSON. Letter in *Nature, Lond.*, **164**, 1002–3 (*Dec.* 10, 1949).

548.737

2792. Structures of molecular addition compounds. II. Methyl cyanide–boron trifluoride, H_3CCN–BF_3. J. L. HOARD, T. B. OWEN, A. BUZZELL AND O. [illegible] SALMON. *Acta Cryst.*, **3** (*No.* 2) 130–7 (1950).

548.7[illegible]

2793. Structures of molecular addition compound I. Monomethyl amine–boron trifluoride, H_3CH_2N–BF S. GELLER AND J. L. HOARD. *Acta Cryst.*, **3** (*No.* [illegible] 121–9 (1950).

548.

2794. Determination of the structure of $CoCl_2 . 2H_2$ by electron diffraction. B. K. VAĬNSHTEĬN (WEI STEIN). *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 2) 301 (1949) *In Russian.*

Using electron diffraction techniques single-crys and powder photographs of $CoCl_2 . 2H_2O$ were mad This compound crystallizes in the monoclinic syste with $a = 7\cdot315 \pm 0\cdot01$ Å, $b = 8\cdot544 \pm 0\cdot01$ Å, c $3\cdot581 \pm 0\cdot005$ Å, $\beta = 97°30'$, specific gravity $2\cdot42 - 2\cdot477$ and $Z = 2$. The space group $C_{2h}^3 - C2/m$. The atomic positions were determin from a Patterson–Harker projection on to the pla perp. to b and from a one-dimensional Fouri synthesis along b [Abstr. 5801 (1949)]. The c ordinates are: Co 000; $\frac{1}{2}\frac{1}{2}0$: Cl $x0z$; $\bar{x}0\bar{z}$; $\frac{1}{2}+x, \frac{1}{2},$ $\frac{1}{2}-x, \frac{1}{2}, \bar{z}$; where $x = 0\cdot245$ and $z = 0\cdot57$: H $0y0$; $0\bar{y}0$; $\frac{1}{2}, \frac{1}{2}+y, 0$; $\frac{1}{2}, \frac{1}{2}-y, 0$; where $y = 0\cdot22$ The observed and calculated intensities for 1 reflections were obtained and agreed well.

A. L. MACK

548.

2795. Investigation of the scattering of electro and the electronographic study of the structure crystals and high polymers. Z. G. PINSKER. *I Akad. Nauk, SSSR* (*Ser. Fiz.*) **13** (*No.* 4) 473– (1949) *In Russian.*

Review of Russian progress in electron diffra tion (includes bibliography and plates). I. Yamzin has experimentally tested the expression f the atomic scattering factor for electrons $f_e(\theta)$ $me^2\lambda^2(Z - f_x)/2h^2 \sin^2\theta$ (where Z is the atom number and f_x the X-ray scattering factor). For t elements Al, Cu, Ag, Au, Mg, Zn and Sn he obtai an agreement of about 5% (table given). T electronograms used for structure determination a mainly obtained from rotated mosaic single-crysta from films of partially oriented crystals on whi the beam is incident obliquely and from polycrysta B. K. Vainshtein (Weinstein) [Abstr. 5801 (194 used intensity measurements for Fourier analys and obtained maps of the potential in crysta Series for the potential are preferable to those f electron density because of their greater convergen X-ray structure amplitudes F_{hkl} and electron amp tudes V_{hkl} are related by $F'_{hkl} = V_{hkl}\pi(h^2+k^2+l^2)$ F_{hkl} to give F'_{hkl}, the amplitude for nuclear scatterin giving possibilities of finding positions of nucl polarization of electron shells and internal fields crystals. Some structures of the AX_2 (where X is halogen) type have been determined; in particul $BaCl_2 . H_2O$ and $C_8Cl_2 . 2H_2O$. Satellite spots ne (200) have been found in electronograms of evaporated on to NaCl. The process of low te perature oxidation of Cu to Cu_2O has been relat to the size and orientation of the crystallites. S. Vekshinskii examined the sublimation of Sb and polymorphy. Electronograms of sheets of polyvi

hol showed 4 diffuse maxima. Intensities were ulated for several models with different sizes and es of regions where neighbouring chains are ply oriented until the experimental results were ounted for. On 100% extension of the sheet a racteristic fibre diagram was obtained. For the amidoether $[COO(CH_2)_2NHCO(CH_2)_8]_n$ the red lengths were perpendicular to the sheet and chains were curled up. On extension of the t a fibre diagram with identity period 16·90 Å given, which was indexed on the basis of an orhombic cell. A. L. MACKAY

548.76

6. Electron microscope and diffraction study of al crystal textures by means of thin sections. R. D. HEIDENREICH. *J. Appl. Phys.*, **20**, 993–1010 (*Oct.*, 1949).

Bethe's dynamical theory of electron diffraction in crystals is developed using the approximation of nearly free electrons and Brillouin zones. The perturbation of the energy levels at a corner of a Brillouin zone is briefly discussed and the manner in which forbidden reflections may arise at a corner pointed out. It is concluded that the kinematic theory is inadequate for interpreting electron images of crystalline films. An electrolytic method for preparing thin metal sections for electron microscopy and diffraction is introduced and its application to the structure of cold-worked Al and an Al–Cu alloy demonstrated. A.

GEOPHYSICS 55

550.312

7. The topographic-isostatic reduction of gravity malies by the aid of small scale maps. W. HEISKA- I AND I. SALA. *Ann. Soc. Sci., Fennicae, Ser. A III,* (*No.* 21) 3–23 (1949).

550.34.08

8. Response characteristics of electromagnetic mographs and their dependence on the instrumental stants. S. K. CHAKRABARTY. *Bull. Seism. Soc. ier.*, **39**, 205–18 (*July*, 1948).

The equation of motion of an electromagnetic mograph and associated galvanometer are derived, glecting hysteresis. Assuming the ground motion be simple harmonic, a general solution is given, luding both steady and transient terms. The ponse is calculated for certain simple initial con- ons and it is shown how these can be used to ermine the instrumental constants. B. C. BROWNE

550.361

9. On the contribution of heat derived from lioactive disintegration in the earth. L. CASER- NO. *Geofis. Pura Appl.*, **15**, 54–9 (*July–Sept.*, 1949) *Italian.*

It is found on the basis of accepted values that the ntribution of K in the production of radioactive at per gm of substance is $23·95 \times 10^{-6}$ *a* cal. per ar, where *a* is the number of gm of K_2O present gm of substance. The equation given by the ry for the calculation of the total quantity of radio- ive heat developed per year by each gm of the bstance becomes: $H = 2·1 \times 10^{-9} N + 23·95 \times 10^{-6} a$, where *N* is the number of α-particles ejected. A.

550.834

10. Seismic sounding of shallow depths. H. DSTRÖM AND R. KOLLERT. *Tellus*, **1**, 24–36 (*Nov.*, 49).

A description is given of the modern field procedure en using the seismic refraction method for measur- of small depths, of the order of only a few ms. small portable instrument equipment used for this rpose is described. A.

550.838

2801. Inductive coupling of a homogeneous ground with a vertical coil. A. BELLUIGI. *Geophysics*, **14**, 501–7 (*Oct.*, 1949).

The problem of the "magnetic pulsating pole" is examined from an analytical viewpoint and an integral solution is reached with the use of Hankel's Integrals. However, a complete explanation was derived only with respect to the horizontal component of the magnetic field. In addition the problem of the "pulsating magnetic dipole" is also explored and similarly a complete explanation is derived only for the horizontal component. The application of the results of these analyses to field prospecting methods is also discussed. A.

551.1

2802. Compressibility-pressure hypothesis and the earth's interior. K. E. BULLEN. *Mon. Not. Roy. Astr. Soc., Geophys. Suppl.*, **5**, 355–68 (*Oct.*, 1949).

The hypothesis has been set down that at pressures ranging from $0·4 \times 10^{12}$ to at least $3·6 \times 10^{12}$ dynes/cm^2 (the latter being the pressure at the earth's centre) the compressibility k^{-1} of a substance at temps. of the order of those in the earth's deep interior is essentially independent of its chemical composition. A simple form of the hypothesis to the effect that k and dk/dp (where p denotes pressure) change continuously and smoothly throughout the earth below a depth of 1 000 km has been discussed in relation to seismic data. The hypothesis entails an abnormally large density gradient in the lowest 200 km of the earth's mantle, and in the earth's inner core, and that these two regions are not chemically homogeneous. It entails that the density near the earth's centre lies between about 16 g/cm^3 and 20 g/cm^3 (apart from a possible accumulation of even denser material very close to the centre). The hypothesis in its simplest form would require the earth's density to be a little higher in the region above the 1 000 km level than the figures given in a previous model. The hypothesis would entail that the inner core is solid, capable of transmitting *S* waves at a speed not less than about 4·9 km/s and probably $< 6·0$ km/s. A.

551.16

2803. On the nature of the earth's core. W. H. RAMSEY. *Mon. Not. Roy. Astr. Soc., Geophys. Suppl.*, **5**, 409–26 (*Oct.*, 1949).

In a previous paper [Abstr. 4295 (1949)] the author has suggested that the density jump at the boundary of the earth's core is due to a phase transition under pressure, and not to the appearance of a new material such as Fe. A metallic type of structure was proposed for the material in the core. In the present paper the transition to the metallic phase is explained in greater detail. Seismological data are used to prove that the core cannot be composed of either Fe or an alloy of Ni and Fe. It is shown how the theory removes certain difficulties arising from the hypothesis of an Fe core, and how it can account for features not hitherto explained. A.

551.46.081

2804. Principal instrumentation problems of deep-sea oceanographic exploration. C. O'D. ISELIN. *Instruments*, **22**, 898–901 (*Oct.*, 1949).

Present problems and techniques in oceanography are reviewed by the Director of the Woods Hole Oceanographic Institution, with remarks on the significance of the acoustic scattering layer at depths of from 75 to 250 fathoms. E. M. FOURNIER D'ALBE

ATMOSPHERE. METEOROLOGY 551.5

551.508.1

2805. Low-temperature performance of radiosonde electric hygrometer elements. A. WEXLER. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 49–56 (*July*, 1949).

The performance was investigated in the temperature range from 0 to $-40°$ C. It was found that an element indicated relative humidity with an average deviation of $\pm 2{\cdot}4\%$ relative humidity from the average calibration for all of the elements tested. The max. deviation in indication of any element was not $> 10{\cdot}5\%$ relative humidity. The lag in response was found to increase markedly with decrease in temp., to depend upon the magnitude and direction of relative humidity change, and the relative humidity from which the change was made. A.

551.508.1 : 621.396.91

2806. A portable ground equipment for the F-type radiosonde. S. P. VENKITESHWARAN, A. KESAVAMOORTHY, B. B. HUDDAR AND B. K. GUPTA. *Sci. Not. India Met. Dep.*, **11** (*No.* 133) 17–20 (1949).

The paper describes a new ground equipment for the F-type radiosonde [Abstr. 3546 (1948)]. The equipment for recording the radio signals from the meteorograph and the time from release of balloon on a moving paper tape is replaced by a small portable unit containing a Cenco impulse counter and an ordinary stop-watch. The super-regenerative receiving equipment is also split into two parts, one unit housing only the power-pack and the d.c. amplifier, while the other contains the u.h.f. receiver only. The paper also discusses the relative merits in using this equipment and in obtaining the records on a moving paper tape. A.

551.508

2807. Remote indicating and recording wind equipment. I–II. R. L. IVES. *Bull. Amer. Met. Soc.*, 3 321–5 (*Nov.*); 352–6 (*Dec.*, 1949).

Equipment and methods for determining wi speed and direction at a remote point, either inte mittently and manually recorded, or automatically, regular intervals, and automatically recorded, a the equipment and techniques for long-peri operation of such systems, are described.

551.508.5 : 533.6.

Calculation of the characteristics of hot-wi anemometers. *See Abstr.* 2250

551.

2808. The physical properties of air with referen to meteorological practice and the air-conditioni engineer. P. A. SHEPPARD. *Trans. Amer. S Mech. Engrs*, **71**, 915–19 (*Nov.*, 1949).

Summarizes numerical values of physical functi and constants, relating to dry and moist air, common use in meteorology and of interest to air-conditioning engineer, and definitions and spe fications of water vapour in the atmosphere.

551.51

2809. Concerning the abundance of atmosphe carbon monoxide. A. ADEL. Letter in *Phys. Re* **76**, 1766–7 (*June* 1, 1949).

Observations in the $4{\cdot}7\,\mu$ region of the so spectrum with the 2 400 lines/in grating spect graph in an *f*/5-Pfund-type spectrometer of fo length 30 in, and photographic galvanometer reg tration, have been carried out at the Lowell Obs vatory in Flagstaff, Arizona, and proved the compl absence of CO. CO_2, which is twice as difficult resolve, was present. Since, however, CO had be found by Migeotte [Abstr. 5898 (1949)] to be p minent in the sun's spectrum at Columbus, Oh its presence is suggested to be of a purely local natu

A. BE

551.51

2810. Seasonal variation of ozone at Washingt D.C. R. STAIR. *J. Res. Nat. Bur. Stand., Wash.*, 209–20 (*Sept.*, 1949).

551.51

2811. Evidence for a world circulation provided the measurements of helium and water vapour dis bution in the stratosphere. A. W. BREWER. *Qu J. Roy. Met. Soc.*, **75**, 351–63 (*Oct.*, 1949).

551.510.

2812. Electron production in the ionosphere. SEELIGER. *Naturwissenschaften*, **36** (*No.* 11) 32 (1949) *In German.*

To illustrate the problems presented in ionosphe studies, a comprehensive survey is made of theo concerning the elementary processes [electron p duction, recombination, etc.] occurring in the *E*-lay

W. J. G. BEYN

551.510.

2813. A study of the height variations of the layer. I. O. BURKARD. *Geofis. Pura Appl.*, 63–8 (*July–Sept.*, 1949) *In German.*

A discussion of the variation of virtual height the ionospheric *F*2-layer with location and season.

551.510.535

.4. True heights of the *F*2 layer. G. R. WHITE .› I. S. WACHTEL. *J. Geophys. Res.*, **54**, 239–42 .pt., 1949).

The true heights of electron density for Washington ›e computed using the parabolic method for winter, ›mmer and equinox of 1945 at noon and at midnight. ›presentative curves were formed by combining the ›a from a large number of days. The distributions ›ained show a lower height of the maximum ›tron-density of the *F*2 region at midday as com-›ed with midnight. The curves are compared with ›ilar curves for Huancayo, in which the height of ›ximum ion-density is greater at midday than at ›dnight. A.

551.510.535

15. Sunrise effects in *F* region from high speed ›ospheric recordings. H. W. WELLS. *J. Geophys. ›s.*, **54**, 277–80 (*Sept.*, 1949).

High-speed recordings of the ionosphere at ›ashington, D.C., from May 5 to June 10, 1949, ›veal that time of initial "sunrise effect" followed ›ound sunrise in all instances. The average time-›terval ≃ 15 min. At the first part of the observing ›riod the observations were farthest removed from ›ne of ground sunrise. Early in June, however, the ›servations approached time of ground sunrise. ›attered values appear to deviate in groups several ›inutes above or below a smooth curve. Such time ›ctuations may be attributed to variations of ›sorption coeff. of the gas through which the ›nizing radiation passes. A.

551.510.535

316. The conference on ionospheric research [at ›ennsylvania State College, June 27–29, (1949)]. *Geophys. Res.*, **54**, 281–8 (*Sept.*, 1949).

Brief summaries are given of 12 papers. Topics ›clude: long-wave propagation, magneto-ionic ›eory, long-distance scatter, sporadic ionization, ›eteor trials and the fading of radio signals.

W. J. G. BEYNON

551.510.535

317. Dynamic probe measurements in the iono-›here. A. REIFMAN AND W. G. DOW. Letter in ›ys. *Rev.*, **76**, 987–8 (*Oct.* 1, 1949).

Short report on rocket measurements of the ion ›nsity in the *E*-layer. The rocket values are in ›asonable agreement with values deduced from ›multaneous radio sounding measurements. Tenta-›e conclusions are drawn concerning the electron ›ergy distribution. W. J. G. BEYNON

551.510.535

318. The measurement of the variation of ionization ›nsity with height in the ionosphere. G. GOUBAU. ›ch. tech. Messen (*Issue No.* 166) (*Ref.* V314—1) ›9–100 (*Nov.*, 1949) *In German.*

A brief survey is made of ionospheric ($h'f$) recording ›ethods and an outline given of the automatic ›cording equipment used between 1938–46, for ›rmal incidence radio sounding of the ionosphere ›the German station Kochel. W. J. G. BEYNON

551.510.535 : 621.396.11

319. Ionospheric absorption. R. N. BRACEWELL AND K. WEEKES. Letter in *J. Appl. Phys.*, **20**, 724 (*July*, 1949).

Reply to earlier letter by McCracken [*J. Appl. Phys.*, **20**, 229 (1949)] concerning the correct expression for the ionospheric absorption of radio waves in a Chapman-type region. W. J. G. BEYNON

551.510.535 : 621.396.11

2820. Nocturnal ionization in the F_2 ionospheric region. N. C. GERSON. *Rev. Mod. Phys.*, **21**, 606–24 (*Oct.*, 1949).

A critical survey was made of the upper atmosphere to an altitude of 300 km, reviewing present knowledge on such factors as composition, winds, temp., pressure and diffusion. On the basis of recent information a model atmosphere having a diurnal temp. cycle above 100 km was adopted. Employing the adopted temp.-altitude function, it was possible to re-examine the rate of recombination occurring in the F_2 ionospheric layer. Considering a temp.-dependent recombination coeff. and including the effect of atmospheric contraction arising from the quotidian temp. variation, it was possible to reformulate the equation describing the rate of change of electron density. On this basis, the predicted value of electron density during darkness in the F_2 ionospheric layer agreed with the observed values very much better than did those obtained when the simple quadratic recombination law was employed. In the course of the investigation, all possible sources of nocturnal ionization were examined. For the F_2 layer insufficient data are on hand to reveal the magnitude of horizontal transport phenomena, which may be of importance. Vertical transport is quantitatively treated. All other sources of ionization seem to be insufficient to maintain the observed ionization levels. A.

551.510.535 : 621.396.11

2821. The panoramic ionospheric recorder. R. LINDQUIST. *Tellus*, **1**, 37–43 (*Nov.*, 1949).

Describes a new type of recorder for ionospheric sounding. It covers the spectrum 1 to 20 Mc/s in 30 sec and is for that reason of great value for investigations in the polar regions, where ionospheric conditions are very fluctuating. The use of a wide band transmitter and receiver has made the short sweep time possible. Only one variable capacitor rotating at low speed is necessary. Automatic tracking between receiver and transmitter is secured through the use of a heterodyne system. Samples of records obtained at Kiruna since the beginning of observations in July, 1948, are shown. A.

551.510.535 : 621.396.11

2822. A single-band 0–20-Mc/s ionosphere recorder embodying some new techniques. T. L. WADLEY. *Proc. Instn Elect. Engrs, Pt III*, **96**, 483–6 (*Nov.*, 1949).

A more detailed account of the recorder described in Abstr. 207 (1948).

551.510.535 : 621.396.11 : 621.396.812.3

2823. Thermal expansion of ionospheric layer and temporary morning disappearance of radio signals. S. S. BANERJEE AND R. N. SINGH. Letter in *Nature, Lond.*, **164**, 925 (*Nov.* 26, 1949).

It is suggested that some observations of the temporary cessation of short-wave reception after

sunrise may be explained if, with increasing solar altitude, thermal expansion of the F_2-layer may more than offset the increase in ionization density.

W. J. G. BEYNON

551.52

2824. Upper-atmosphere temperatures from Helgoland big bang. E. F. Cox, J. V. Atanasoff, B. L. Snavely, D. W. Beecher and J. Brown. *J. Met.*, **6**, 300–11 (*Oct.*, 1949).

Microbarographs situated 66 to 1 000 km *SSE* from Helgoland recorded disturbances initiated by the 5 000-ton TNT explosion on that island, April 18, 1947. Special balloons at 4 meteorological stations obtained weather data to 29·5 km altitude at blast time. Wind velocities are considered negligible up to balloon summits. Assuming negligible winds at higher altitudes, interval velocities of abnormal microbarometric signals permit calculations of upper-atmosphere temps. Temp. rises steeply from 221°K at 32 km to 285°K at 42·5 km, then more slowly to 294°K at 55 km. Very long period waves recorded beyond 400 km are believed to have returned from the second high-temp. region of the upper atmosphere. Arrival times are best matched by assuming a cold layer between 55 and 86 km, with lowest temp. 170°K extending from 64 to 79 km. A steep rise to 296°K at 86 km precedes a smaller gradient to 399°K at 172 km. Not much confidence is held in results above 100 km.

A.

551.578.1 : 621.396.9

2825. The rain required for a radar echo. D. W. Perrie. *Bull. Amer. Met. Soc.*, **30**, 278–81 (*Oct.*, 1949).

A microwave radar was operated at Clinton, Ont., Canada, from March until October, 1945, for the purpose of studying radar echoes from rain. The principal contribution from this operation has been a direct determination of the amount of rain (measured both by gauge and by drop measurements) required to produce an echo at a given range. A.

551.594.22 : 621.316.99

2826. The effect of geologic inequalities on the path of lightning, as indicated by model experiments. H. Norinder and O. Salka. *Tellus*, **1**, 1–5 (*Nov.*, 1949).

To investigate the influence of lightning strokes on surfaces with geologically non-homogeneous structures, experiments were carried out in a model test tank filled with dried sand, and in this a vein of Fe ore or other materials. Artificial lightning discharges against the surface of the test tank were undertaken by the aid of an impulse generator at voltages of 1 MV and spark lengths of 75 and 170 cm respectively. It was found that a discharge from a positive electrode was pronouncedly influenced by a geological discontinuity such as an ore vein. On the other hand, negative strokes hit the sand surface at random, independent of geological discontinuities. The difference in effects from the two polarities is related to the mechanism of the discharges and the development of leaders initiating the main discharges in the form of the lightning ones. A

551.594.221 : 621.316.9

2827. Luminosity of a lightning flash. I. E. Balygin. *Elektrichestvo* (*No.* 7) 47–50 (*July*, 1949) *Russian.*

A physical interpretation of the intermittent luminosity is attempted, based on an analogy with non-stationary processes in distributed electrical filter networks. As a typical example a lightning flash with 3 strokes is chosen and its physical characteristics are expressed in units of length and time. The processes observed are explained by multiple reflection and refraction of the lightning leader strokes from the cloud. A. Landman (R

551.594.6 : 621.396.821 : 621.317.3

2828. Study of the wave-forms of atmospherics. S. R. Khastgir and R. Roy. *Phil. Mag.*, **40**, 1129–44 (*Nov.*, 1949).

An account is given of the results of experiments made at Dacca in the monsoon months of 1947, on the waveforms of distant atmospherics. The method was to examine, by means of a c.r.o. with linear time base, the potential variations developed across a condenser in a damped aerial, the time-constant of which was $\ll$ the duration of the atmospheric pulse. An interpretation of the observed waveforms is suggested. The work of Schonland and others [*Proc. Roy. Soc. A*, **152**, 595 (1935); **164**, 132 (1938)] is relevant. L. S. Goddard

551.59

2829. Errata: Abnormal audibility zones in long distance propagation through the atmosphere. E. F. Cox. *J. Acoust. Soc. Amer.*, **21**, 501 (*Sept.*, 1949).

See Abstr. 6620 (1949). Points out that Schrödinger's dispersion theory deals specifically with vertically travelling waves, hence cannot be applied near the apex of abnormal signal paths. The original paper must therefore be regarded as presenting experimental evidence of dispersion, yet unexplained by theory. A

551.596 : 534.23

Some new experiments on the propagation of sound in the atmosphere. *See Abstr.* 2270

BIOLOGY 57/59

578

2830. Physical approach to the study of biological systems. J. T. Randall. *Nature, Lond.*, **164**, 521–2 (*Sept.* 24, 1949).

The contribution of experimental physics to biological problems was brought together at the Physics Convention, Buxton, May (1949). X-ray low scattering technique has given information on size and shape of the particles in haemoglobin and egg albumen solutions. Structure of proteins has been advanced by X-ray analysis and electron microscopy, showing there is at least one level of organization between polypeptide chain and macroscopic fibre; this consists of microfibrils 100–1 000

...k. These in turn are globular assemblies of more ...plex structure. Trompomyosin undergoes a ...rsible change from fibrous to probably cor... ...ular state; other typically corpuscular proteins ...sist of bundles of polypeptide chains as revealed ...peptide gramicidin. Tissue culture technique ...vides thin material for electron microscope ...mination but the development of "electron" ...s seems essential. Crystalline viruses, not yet ...ses of higher molecular weight, have been ...mined by electron microscopy. Importance of ...yme activity for understanding of virus structure ... discussed, also multiplication of virus particles ...host cells. Reflecting microscope studies have ...n applied to u.v. spectra of single haemoglobin and ...globin crystals showing a strong dichroic effect, ... plane of the indol group being perp. to the *a*-axis. ...st of 16 references is given. J. JACOBS

591.185.5

...1. Aural microphonics in the cochlea of the ...nea pig. H. DAVIS, B. E. GERNANDT, J. S. RIESCO-...cCLURE AND W. P. COVELL. *J. Acoust. Soc. ...er.*, **21**, 502–10 (*Sept.*, 1949).

...lectro-acoustic equipment and methods for the ...dy of aural microphonics and action potentials of ...oratory animals are described. A new feature is ... placement of electrodes not only on the round ...ndow but also in one or more very small holes ...lled into the cochlea of the guinea pig. Analysis ...the aural microphonics so recorded confirm the ...nclusions of Wever and Lawrence, of Békésy, and ...ers. A.

591.58

...32. Analysis of a bat's warning cry. W. H. ...ELEMEIER. Letter in *J. Acoust. Soc. Amer.*, **21**, ...1–2 (*Sept.*, 1949).

A caged bat was made to give his warning cry by ...owing on his fur or by disturbing him with a small ...d. The sound emitted was analysed by a frequency ...alyser and c.r.o., etc.—the microphone (Western ...ect. Type 640 AA) being held about 10 cm from ...e bat's mouth. The cry appeared to consist of a ...y intense but narrow band between 13 and 14 kc/s ...d of a nearly continuous noise spectrum of con...derable intensity between 50 and 80 kc/s. The ...ensity level in the above observations was 104 to ...0 db in the 13–14 kc/s band. A low pitch buzz, ...out 100 pulses/sec, could be heard a few feet away ...m the bat. A. B. WOOD

...EDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.84 : 523.82 : 525.722

...33. The scintillation of stars. H. HARTRIDGE ...D R. A. WEALE. Letter in *Nature, Lond.*, **164**, ...9–1000 (*Dec.* 10, 1949).

...t is shown that a small local source, the observation ...which is not modified by atmospheric disturbances, ...pears to scintillate and change its hue when its ...ghtness is sufficiently reduced. A physiological explanation of this phenomenon is that there are local variations in the retinal sensitivity, slight movements of the eye thus giving rise to the apparent twinkling of the source. The scintillation of stars may be ascribed to a similar cause though physical factors may contribute to the effect. R. WEALE

615

2834. The organization of hospital physics departments. Symposium. I. L. F. LAMERTON. *Brit. J. Radiol.*, **22**, 588–91 (*Oct.*, 1949).

The peculiar requirements of a full-time hospital physicist, and the need for suitably trained technical staff, particularly in a radiotherapy dept., are discussed. A "measurement clinic" staffed by one or more radiographers under the direction of the physicist is of special advantage. F. T. FARMER

615

2835. The organization of hospital physics departments. Symposium. II. Physics in a large radiotherapy centre. H. MILLER. *Brit. J. Radiol.*, **22**, 591–6 (*Oct.*, 1949).

The requirements in a large treatment centre, including apparatus for radiation measurement and a well-equipped workshop are outlined, and the proportion of physical, medical and technical staff for efficient working is discussed. F. T. FARMER

615

2836. The organization of hospital physics departments. Symposium. III. The broader view of hospital physics. S. B. OSBORN. *Brit. J. Radiol.*, **22**, 596–8 (*Oct.*, 1949).

The scope of physics outside radiotherapy, including radiodiagnosis, radiation protection, audiometry, anaesthetics and other applications of physics to medicine, is reviewed briefly. F. T. FARMER

615.849 : 621.386

2837. A 250 kilovolt X-ray equipment for deep therapy. D. H. DONALDSON AND D. HALLIDAY. *G.E.C. J.*, **16**, 175–83 (*Oct.*, 1949).

A new attempt to produce adequate X-ray output with max. manoeuvrability of apparatus. A "divided generator" system supplies half the (pulsating) tube voltage, from two Villard generators in the room above, by cables through two steel shafts, which carry the tube head. Transformers in the head amplify this to $\pm$ 125 kVp. Advantages are: (1) low rating (62·5 kVp) cables are used, (2) low ratio transformers in the head enable it to be kept to reasonable size ($29 \times 24 \times 12$ in), (3) absence of under-tube support gives unhindered movement of treatment couch, (4) it follows that wide-angle freedom of motion is possible. Vertical motion of the shafts is controlled at two speeds. Target is cooled by circulating oil pump. Alternative floor mounting is available. Output in air at 50 cm is 50 r/min (H.V.L. = 1·5 mm Cu). The control table, cleanly designed, includes many indicators and necessary safety devices. D. V. MABBS (R)

616 : 537.591

Influence of cosmic radiation on induced carcinogenesis in mice. *See Abstr.* 2532

PHOTOGRAPHY 77

771.53

2838. Nature and development of the latent photographic image. J. EGGERT. *An. Real Soc. Esp. Fis. y Quim., A*, **45**, 203–14 (*May–June*, 1949) *In Spanish.*

A comprehensive review of the subject.

L. PINCHERLE

771.53

2839. Action of wood on a photographic plate. V. P. NARAYANAN NAMBIYAR. *Curr. Sci.*, **18**, 284–6 (*Aug.*, 1949).

The photographic action of wood (European timber) in contact with a photographic plate has been studied by W. J. Russel [*Proc. Roy. Soc.*, **61**, 424–33 (1897)], and its activity was explained by the action of H_2O_2 produced by the resinous bodies present in the wood. Investigations were made on Indian timbers for which a much increased exposure time was required to obtain a photographic image, than with European timber. If the wood was given pre-exposure to sunlight and then placed in contact with a photographic plate, the photographic action was considerably increased. In order to check the explanation given by Russel, resinous bodies present in the wood were eliminated by treatment in a mixture of benzene and alcohol and the photographic action then practically ceased. R. H. HERZ

771.53 : 537.531

The photographic action of X-rays in the 1·3 to 0·01 A range. *See Abstr.* 2494

771.535

2840. When was the "latent image" discovered? E. STENGER. *Z. wiss. Photogr.*, **44** (*Nos* 8–9) 182–5 (1949) *In German.*

In a short historical review in which extracts from letters by Niepce, Daguerre and Talbot's memoirs are quoted, it is concluded that the first discovery of the latent image is due to Daguerre in 1835.

R. H. HERZ

771.535 : 541.141.1

2841. The quantum yield in the photolysis of silver halide in photographic layers sensitized by photolytically formed silver. W. MEIDINGER. *Z. wiss. Photogr.* **44** (*Nos* 8–9) 137–72 (1949) *In German.*

In a previous paper by the same author [see Abstr. 6660 (1949)] it was shown that extremely high quantities of photolytic Ag are formed in Ag halide emulsions containing a halogen acceptor, if the emulsions were exposed within a spectral region in which the Ag halide causes only a very low absorption. This observation is interpreted as an autosensitization of the grains caused by the photolytically formed Ag which acts apparently as a sensitizer. The changes in absorption of light quanta of different wavelengths by photolytic Ag in AgBr and AgCl layers with and without acceptor are discussed in detail. It is found that a post-exposure to a given number of light quanta of $\lambda = 578$ and 700 mμ (region of low absorption of Ag halide) is the most effective in producing photolytic Ag, the greater the pre-exposure at $\lambda = 436$ mμ (region of high absorption) until saturation of the formation of photolytic Ag occurs. The quantum yield for the so-called sensitizing photolysis is determined for photographic layers containing halogen acceptors and is shown to decrease rapidly with increasing wavelength from 436–700 mμ. R. H. HERZ

778

2842. Photographic sandwich emulsion technique in nuclear chemistry. E. PICCIOTTO. *C.R. Acad. Sci. Paris*, **228**, 2020–2 (*June* 27, 1949) *In French.*

A drop of the radioactive aqueous solution is applied to the surface of a photographic emulsion layer of the type designed for the direct recording of nuclear tracks. After drying, a [presumably moistened] film of a similar emulsion is laid on top of the first. The two emulsion layers, of combined thickness 200 μ when dry, join up perfectly and there is no distortion of tracks, provided that excessive swelling of the gelatine during processing is avoided. W. F. BERG

778.37 : 621.397

2843. An iconoscope electro-optical shutter for high speed photography. H. A. PRIME AND R. C. TURNOCK. Note in *Rev. Sci. Instrum.*, **20**, 82 (*Nov.*, 1949).

AUTHOR INDEX

April 1950

ADIE, P., 2443
AS-ZADE, A. K., 2396
EL, A., 2809
LER, F. P., 2596
ENO, M., 2518
ULOV, N. A., 2580
EKSEEVA, K. I., 2542
EXANDER, L., 2493, 2704
FREY, G. F., 2437
GER, R. S., 2516
IKHANYAN, A. I., 2558–9
MBROSE, A., 2314
MMIRAJU, P., 2665
MON, S., 2308
NDREW, E. R., 2576
NDREWS, E. G., 2123
NTONOFF, G., 2233
PPLEYARD, R. K., 2526
RCAIX, S., 2708
RGENCE, E., 2599
RMSTRONG, G. T., 2429
RSENEVA-GEĬL, A. N., 2459
RTYUKHOV, G. YA., 2557
RZELIÈS, H., 2597
SHFORTH, G. K., 2407–8
SHMAN, L. E., 2306
SSUR, E. L., 2720
SUNDI, R. K., 2329, 2333
TANASOFF, J. V., 2824
TTREE, R. W., 2749
VAKYANTS, G. M., 2465
VERBUKH, R. E., 2439
YNARD, R., 2319
YRE, R. S., 2205
ZIMOV, S. A., 2533

BACKUS, R. C., 2714
BACON, G. E., 2690
BAGGETT, L. M., 2501
BAK, M. A., 2470
BALLARIO, M. C., 2149
BALYGIN, I. E., 2827
BAME, S. J., JR. 2501
BANDERET, E., 2355
BANERJEE, S. S., 2823
BARADZEĬ, L. T., 2534
BARBARON, M., 2307
BARBER, C. R., 2419
BARBOUR, J. M., 2278
BARER, H., 2390
BARIT, I. YA., 2545
BARNETT, S. J., 2608
BARTELS, H., 2418
BASTIEN, P., 2259
BAUPLÉ, R., 2345
BEACH, L. A., 2653–4
BEAR, R. S. 2775
BECHERT, C., 2405
BECK, C. K. 2746
BECK, P. A., 2765, 2767
BECKER, M., 2352–3
BEECHER, D. W., 2824
BEEMAN, W. W., 2488
BELENKIĬ, S. Z., 2536
BELLUIGI, A., 2801
BELOVITSKIĬ, G. E., 2554
BENNETT, W. H., 2503
BERNARDINI, G., 2560
BERRY, C. E., 2246
BESSO, M. A., 2631
BESTENREINER, F., 2643, 2647
BIBERMAN, L. M., 2164
BIER, M., 2380–1
BIERMAN, A., 2497
BIERMANN, L., 2316
BIONDI, M. A., 2527
BIRGER, N. G., 2548
BIRKS, L. S., 2709–10
BITTER, F., 2620
BLAHA, F., 2609
BLANC, D., 2512
BLANDIN, J., 2763
BLEAKNEY, W., 2248, 2266
BLETON, J., 2259
BLOCHER, J. M., 2432
BLOKHINTSEV, D. I., 2693
BLOSSER, D. R., 2572
BLOTT, J. F. T., 2739
BLUM, J., 2422
BOLDUAN, E. A., 2775
BOLT, R. H., 2286
BONINO, G. B., 2325
BONNELL, D. G. R., 2209
BONNOR, W. B., 2739
BOOTH, J., 2532
BOTHE, W., 2499
BOTTOMLEY, G. A., 2240
BOUCHEZ, R., 2639, 2650
BOUIGUE, R., 2162
BOYARINTSEV, D. I., 2393
BRACEWELL, R. N., 2819
BRAGG, J. K., 2349
BRAUNEWELL, W., 2606
BREIT, G., 2195
BREKHOVSKIKH, L. M., 2274, 2594
BRENTANO, J. C. M., 2760
BREWER, A. W., 2811
BRIDGMAN, P. W., 2743
BRILLOUIN, L., 2588
BRINKLEY, S. R., JR., 2264
BRISCOE, H. V. A., 2237
BRODA, E., 2643, 2647
BRODIN, J., 2257, 2591
BRODSKY, R. F., 2247
BROMLEY, L. A., 2402
BROSSEL, J., 2334, 2337
BROWN, A. A., 2528
BROWN, C. B., 2456
BROWN, G. E., 2195
BROWN, H., 2636
BROWN, J., 2824
BROWN, J. R., 2659
BROWN, S. C., 2474–5, 2527
BRUCE, C. E. R., 2153
BRUNTON, D. C., 2681
BUECHNER, W. W., 2668–70
BULGAKOV, N. V., 2581
BULLEN, K. E., 2130, 2802
BUNN, C. W., 2789
BURGE, E. J., 2604
BURGERS, J. M., 2267–8, 2736
BURKARD, O., 2813
BURTON, R. A., 2389
BURWELL, C. G., 2166
BUSCH, G., 2449
BUZZELL, A., 2792

CAMPBELL, I. E., 2432
CARLIN, J. R., 2210
CARMAN, P. D., 2173
CARRARA, N., 2587
CASERTANO, L., 2799
CASSEL, H. M., 2758
CAUCHOIS, Y., 2484
CAUVILLE, R., 2454
CELIS, R., 2426
CHAKRABARTY, S. K. 2798
CHALKER, W. R., 2383
CHAMBERLAIN, K., 2310
CHAMIÉ, C., 2667
CHANDRASEKHAR, S., 2222
CHARBONNIÈRE, R., 2443
CHENG, P. T., 2764
CHESTER, W., 2258
CHIOZZOTTO, M., 2518
CHISTYAKOV, P. N., 2479
CHUVILO, I., 2544
CINI, M., 2719
CLAREBROUGH, L. M., 2721
CLARK, G. L., 2788
CLEGG, J. A., 2132–4
CLOUAIRE, J., 2732
CLUSIUS, K., 2239
COLACEVICH, A., 2149
COLE, A. R. H., 2343
COLLINGE, B., 2513
COMOLET, R., 2225
COOK, C. S., 2651
COOPER, B. S., 2392
CORAK, W. S., 2464
CORINALDESI, E., 2189
CORNFORD, E. C., 2598
CORRSIN, S., 2218
CORTINI, G., 2560
COSYNS, M. G. E., 2687
COULSON, C. A., 2615, 2632
COUTURE-MATHIEU, L., 2366
COVELL, W. P., 2831
COWLEY, J. M., 2782
COX, E. F. 2824, 2829
CRABOL, J., 2273
CRANK, J., 2235
CRAWFORD, M. F., 2363, 2624–5
CREAGAN, R. J., 2663
CREITZ, E. C., 2315
CREUTZ, E., 2694
CROWFOOT, D., 2789
CURIE, I., 2660
CURTIS, A. R., 2182
CURTISS, C. F., 2748

DAION, M. I., 2558
DANFORTH, W. E., 2428
DANILOV, V. I., 2400
DANSER, H. W., 2279
DARWIN, C., 2117, 2531
DÄTWYLER, G., 2250
DAUVILLIER, A., 2556
DAVIDENKOV, N. N., 2720
DAVIDSON, H. R., 2297
DAVIDSON, I. A., 2132
DAVIDSON, P. M., 2469
DAVIES, J. H., 2688
DAVIS, H., 2831
DAY, J., 2441
DE, H. P., 2523
DE GREVE, L., 2426
DE GROOT, S. R., 2252, 2650
DE KERVERSAU, 2259
DE KLERK, D., 2630
DE LA RIPELLE, F., 2525
DELHAYE, J., 2160
DEPPERMANN, C. E., 2301
DESVIGNES, F., 2376
DE VAUCOULEURS, G., 2154
DE VRIES, H., 2630
DEXTER, D. L., 2488
DICKINSON, T. M., 2498
DICKINSON, W. C., 2622
DIETRICH, I., 2458
DIETZE, T. W., 2498
DIKUN, P. P., 2360
DILWORTH, C. C., 2687
DIRKS, W. H., 2154
DOBROTIN, N. A., 2535 2548
DOLCETTA, A., 2122
DOLINSKI, S., 2285
DOLLFUS, A., 2129
DONALDSON, D. H., 2837
DONALDSON, D. M., 2791
DOUGLAS, A. E., 2626
DOW, W. G., 2817
DRELL, S. D., 2621
DRUCKER, D. C., 2734
DUBOIS, E., 2262
DUMOND, J. W. M., 2659
DUNCANSON, W. E., 2632
DUQUEROIX, L., 2176

ECHENSTOVA, A. I., 2731
ECKART, G., 2592
ECKER, P. G., 2422
ECKERSLEY, T. L., 2602
EGGERT, J., 2838
EHMERT, A., 2137
EHRENBERG, W., 2455
EIDUS, L. K., 2548, 2557
EKLÖF, O., 2148
EKSTEIN, H., 2734
ELIEZER, C. J., 2193
ELLIOTT, A., 2314
ELSTON, J., 2413
EMMERICH, C. L., 2399
EULER, J., 2375
EVALDSON, R. L., 2205
EVANS, H. T., JR., 2776
EVANS, M. W., 2411

FABELINSKIĬ, I., 2444
FAGGIANI, D., 2288
FALK, C. E., 2694
FALKOFF, D. L., 2658
FAN, H. Y., 2352–3
FANKUCHEN, I., 2774
FANO, U., 2485
FARAGGI, H., 2677
FARNSWORTH, H. E., 2528
FARRANT, J. L., 2491
FEDEROV, E. P., 2171
FEDORUS, G. A., 2462
FEHRENBACH, C., 2151, 2162
FEIN, R. S., 2415
FELDMAN, C., 2321
FELDMAN, D., 2188
FELLGETT, P. B., 2293
FERMI, E., 2686
FERRARO, V. C. A., 2139
FESHBACH, H., 2678
FEYNMAN, R. P., 2187
FIELD, G., 2189

Filçakova, H., 2667
Finkelstein, R., 2685
Fischer, I., 2759
Fisher, I. Z., 2575
Fisher, T. Z., 2457
Fleeman, J., 2696
Fletcher, C. H. 2248
Fletcher, R. C., 2471
Foëx, G., 2571
Foëx, M., 2450
Foldy, L. L., 2271
Foley, H. M., 2618
Ford, L. H., 2586
Forrer, R., 2633
Fournet, G., 2490
Fowler, W. A., 2672
Franck, U. F., 2752
Frank, I. M., 2553
Franzinetti, C., 2539
Frederikse, H. P. R., 2755
Frenkiel, F. N., 2219, 2220
Fréon, A., 2555
Frerichs, R., 2515
Freymann, M., 2441
Freymann, R., 2441
Fripiat, J. J., 2613
Frish, S. E., 2909
Furry, W. H., 2191

Gailloud, M., 2646
Galikina, O. S., 2580
Gänger, B., 2477
Garfitt, R. G., 2500
Garlick, G. F. J., 2357–8
Garner, F. H., 2384, 2407–8
Garrison, J. B., 2425
Gaudry, F., 2766
Gaze, V. F., 2163
Gehlhoff, P. O., 2605
Geĭlikman, B. T., 2198
Geller, S., 2793
Gent, W. L. G., 2616
George, E. P., 2532, 2537
George, M., 2532
Gernandt, B. E., 2831
Gerould, C. H., 2716
Gerson, N. C., 2820
Giamboni, L. A., 2608
Gibson, A. F., 2357
Gibson, K. S., 2295
Gill, E. W. B., 2437
Gilles, A., 2345
Gilstein, J. B., 2420
Gilvarg, A. B., 2385
Girard, P., 2443
Glocker, R., 2508
Goff, J. A., 2433
Göing, W., 2418
Golay, M. J. E., 2292
Gold, M. T., 2318
Gold, T., 2128
Goldberg, L., 2146, 2331
Golden, S., 2747
Goldenblat, I. I., 2725
Goldsbrough, G. R., 2172
Gollnow, H., 2126–7
Gordon, P., 2777
Gorter, C. J., 2630, 2755
Goubau, G., 2818
Goubeau, J., 2367
Gould, F. A., 2211
Gray, P., 2410
Gray, W. M., 2624
Gregg, E. C., Jr., 2496
Grigorov, N. L., 2535
Gross, B., 2722
Gross, E. F., 2344, 2361, 2611
Groszkowski, J., 2242
Guillaud, C., 2564, 2569
Gupta, B. K., 2806
Guro, G., 2544
Gurzadyan, G. A., 2155–6
Guth, E., 2673

Haenny, C., 2646
Haine, M. E., 2500
Hall, C. E., 2715
Hall, J. A., 2424
Hall, W. H., 2492
Halliday, D., 2837
Halliday, D. J., 2174
Halpern, O., 2697
Hamermesh, B., 2675
Hanson, A. O., 2700
Haringx, J. A., 2201
Harman, W. W., 2436
Harrand, M., 2364
Harrington, E. L., 2245
Hartridge, H., 2833
Haskell, N. A., 2256
Hatfield, H. S., 2427
Hawkins, F. S., 2392
Hedström, H., 2800
Heidenreich, R. D., 2796
Heiskanen, W., 2797
Henkels, H. W., 2452
Henry, M. E., 2235
Herczog, A., 2340
Herman, L., 2330, 2339
Herman, R., 2339
Herpin, A., 2717
Hers, J., 2175
Herzberg, G., 2626
Hess, D. C., Jr., 2638
HeténYi, M., 2200
Hett, J. H., 2420
Heymann, F. G., 2476
Hiatt, C. W., 2422
Hill, C. G. A., 2359
Hirschfelder, J. O., 2745, 2748
Hirst, W., 2756
Hoard, J. L., 2792–3
Hoerlin, H., 2494
Hoerni, J., 2712
Holt, J. R., 2507
Hopkins, H. G., 2203
Hopkins, R. E., 2302
Hormats, S., 2423
Horning, E. S., 2532
Horton, C. W., 2595
Houghton, H. G., 2383
Houston, W. V., 2463
Houstoun, R. A., 2291
Howells, E. R., 2780
Hubbard, P. G., 2215
Huddar, B. B., 2806
Hudson, R. P., 2577
Hughes, H. K., 2617
Hughes, R. H., 2312
Hulburt, H. M., 2745
Hull, H. H., 2446
Hung, C. S., 2529
Hurd, Y. G., 2298

Imm, L. W., 2297
Inghram, M. G., 2638
Ioffe, B. S., 2741
Iselin, C. O'D., 2804
Ito, T., 2783, 2786
Ivanov-shits, K. M., 2270
Ivanovskiĭ, V. I., 2580
Ives, R. L., 2807

Jackson, L. C., 2241
Jacobsen, L. S., 2205
Jacobson, W. R., 2296
James, H. M., 2197
Jaswon, M. A., 2784
Jeffree, J. H., 2304
Jen, C. K., 2348
Johnson, E. O., 2478
Johnson, J. C., 2401
Jones, C. K., 2707
Jones, F. E., 2598
Jones, H. E., 2306
Jones, R. C., 2300
Judd, D. B., 2386
Justi, E., 2605

Kaczor, E., 2310
Kahan, T., 2592
Kaĭdanovskiĭ, N. L., 2282
Kaiser, T. R., 2504–5
Källén, G., 2194
Kamalyan, V., 2559
Kamei, T., 2324
Kamenetskaya, D. S., 2400
Kamieński, M., 2135
Kammerer, A., 2724
Kaplan, S. A., 2178
Kaplan, W., 2202
Karr, P. R., 2486
Kastler, A., 2334
Kaufman, B., 2772–3
Kaufman, H. S., 2774
Kaye, W., 2713
Kaye, W. I., 2788
Kê, T. S., 2742
Kelly, F. M., 2624
Kelting, H., 2762
Kesaev, I. G., 2472
Kesavamoorthy, A., 2806
Ketelaar, J. A. A., 2786
Ketelle, B. H., 2652
Kharitonov, V. M., 2558
Khastgir, S. R., 2828
Khrimyan, A., 2559
Kiely, D. G., 2593
Kirkwood, J. G., 2264
Kittel, C., 2563, 2565
Klasens, H. A., 2359
Klein, M. J., 2254
Klein, M. W., 2730
Kling, R., 2273
Klug, H. P., 2704
Knauer, F., 2689
Koch, B., 2473
Kohaut, A., 2391
Kollert, R., 2800
Konstantinov, A. A., 2558
Kónya, A., 2495
Koppe, H., 2683
Korablev, L. N., 2540, 2546
Korsching, H., 2648
Kosman, M. S., 2438–9
Kourganoff, V., 2699
Kovasznay, L. S. G., 2218
Kozieł, K., 2116
Kramers, H. A., 2261
Krasilnikov, V. A., 2270
Kraus, W., 2395
Krzywoblocki, M. Z., 2216
Kuczynski, G. C., 2703
Kulikov, A. M., 2541
Kunze, P., 2584
Kurakin, A. I., 2535
Kuratani, K., 2362
Kurnosova, L. V., 2548
Kurtz, S. S., Jr., 2308

Lachenbruch, S. H., 2566, 2568
Ladner, A. W., 2283
Laffittee, P., 2413
Laforgue, A., 2612
Lafoucrière, J., 2506
Lamar, E. S., 2378
Lamare, A., 2724
Lambeir, R., 2426
Lambert, J. D., 2398
Lamerton, L. F., 2834
Lamkin, J. C., 2486
Landsberg, P. T., 2453, 2482
Lark-Horovitz, K., 2351
Lashkarev, V. E., 2461–
László, Z., 2234
Lauritsen, C. C., 2672
Lawson, A. W., 2425
Lecoin, M., 2661
Leland, W. T., 2637
Levenson, M. E., 2118
Levi, D. L., 2757
Lewis, C. R., 2206
Lewis, I. A. D., 2521
Lighthill, M. J., 2120, 2249
Lin, C. C., 2221
Lind, D. A., 2659
Lindblad, B., 2160
Lindquist, R., 2821
Ling, D. S., Jr., 2658
Linnett, J. W., 2409, 2414
Lipmanov, E. M., 2185
Lobanova, N. V., 2387
Lock, J. M., 2576
Lock, W. O., 2688
Long, D. A., 2365
Long, L. H., 2431
Long, R., 2407–8
Longini, R. L., 2244
Loofbourow, J. R., 2342
Loshaek, S., 2415
Lovell, A. C. B., 2133–4
Low, W., 2618
Lowen, I. S., 2662
Lubny-Gertsyk, A., 2335
Lundby, A., 2645
Lundgren, G., 2785
Lundquist, S., 2230
Luneburg, R. K., 2697
Lyot, B., 2129
Lyubimov, A. L., 2540, 2546, 2548

McAfee, K. B., Jr., 2312
McCance, A., 2728
McCrone, W. C., 2764
MacDonald, A. D., 2286, 2474–5
MacDonald, D. K. C., 2468
MacGillavry, C. H., 2786
McGowan, F. K., 2644
McKay, K. G., 2517
McKellar, A., 2169
Mackenzie, J. K., 2718
McMath, R. R., 2146, 2313, 2331
Macradyen, A., 2421
MacRae, D. A., 2168
Madison, T. C., 2349
Maĭzel, S. O., 2294
Malm, R., 2668
Malter, L., 2478
Manfredini, A., 2560
Marcus, P. M., 2467
Maréchal, A., 2303
Marton, L., 2566, 2568
Mash, D., 2444
Mason, D. E., 2358
Massie, D. S., 2240
Mataré, H. F., 2451
Mathews, F. W., 2779
Matthews, P. T., 2186, 2190
Matossi, F., 2350, 2369
Maxwell, E., 2467
Mayants, L., 2444
Mayer, H., 2701
Mazur, J., 2784
Mecke, R., 2440
Meidinger, W., 2841
Meissner, H. P., 2231
Meissner, M., 2351
Melkonian, E., 2679–80
Mendelssohn, K., 2394, 2468

RRILL, P. W., 2166
RTON, G., 2125
YER, L., 2416
CHAELS, A. S., 2231
CHELS, W. C., 2448
LLER, A. V., 2540
LLER, E. L., 2411
LLER, H., 2835
LNE, E. A., 2180–1
NNHAGEN, L., 2323
ZUSHIMA, S., 2362
HLER, O. C., 2146, 2313, 2331
HR, C. B. O., 2547
NECKE, O., 2619
NTGOMERY, C. G., 2538, 2550–1
NTGOMERY, D. D., 2550
OKHERJI, A., 2570
ORHOUSE, R. G., 2192
ORETTE, C., 2684
ORGAN, A. I., 2402
ORGAN, F. H., 2428
ORI, H., 2787
ORINO, Y., 2362
OROZOV, V., 2559
ORRIS, D. P., 2778
ORRISH, A. H., 2671
OTT, N. F., 2484
OULTON, W. G., 2692
ROZOWSKI, S., 2322, 2336
UIRHEAD, H., 2688
ÜLLER, E. W., 2768
ÜLLER, F. H., 2754
ULLIN, C. J., 2673
UNK, M. M., 2251
URAKAWA, 2324
USKHELISHVILI, G., 2559
YERS, O. E., 2641

AFE, J. E., 2435
AGAMIYA, T., 2445
AJAR, M., 2646
ARAYANAN NAMBIYAR, V. P., 2839
ASSAU, J. J., 2168
ATAF, R., 2650
EELANDS, L. J., 2528
EKRASHEVICH, I. G., 2457
ELSON, E. B., 2435
EUERT, H., 2473
EUMAN, M., 2191
EUMANN, E. P., 2279
EVRAEV, A. T., 2546
EWBURGH, R., 2341
EY, E. P., 2549
ICKOLS, D. G., 2740
ICODEMUS, D. B., 2696
IENHUIS, K., 2243
IER, A. O., 2510
IJENHUIS, W., 2119
IKITINE, S., 2354
IKOLAEV, V., 2544
IKOLAEVSKAYA, N. N., 2470
ISSAN, A. H., 2384
ORD, F. F., 2380–1
ORDEN, K., 2299
ORINDER, H., 2826
ORRISH, R. G. W., 2431
YE, J. F., 2729

CCHIALINI, G. P. S., 2687
DINTSOV, M. G., 2263
ELE, H. A., 2497
LSEN, H. L., 2415
LSEN, J. L., 2394
LSON, N., 2625
NSAGER, L., 2773
PPENHEIMER, F., 2549
RLEANS, G. P., 2756
SBORN, S. B., 2836
TT, D. G., 2666
WEN, E. A., 2778
OWEN, G. E., 2651
OWEN, T. B., 2792

PACHNER, J., 2269
PADHYE, M. R., 2328–9, 2333
PAGE, N, 2687
PAGE, R. S., 2500
PAILLOUX, H., 2208
PARKASH, O., 2514
PARKER, G. W., 2652
PARRY, G. S., 2790
VAN PATTER, D. M., 2674
PAUL, W., 2838
PAVINSKIĬ, P. P., 2361
PEACOCK, C. L., 2653–4
PECKER, C., 2147
PECKER, J. C., 2147
PEISER, A. M., 2747
PENNING, F. M., 2243
PENROSE, R. P., 2573
PEREY, M., 2661
PERRIE, D. W., 2825
PERROT, M., 2708
PETRAUSKAS, A. A., 2766
PETROVA, N. M., 2179
PEUTEMAN, A., 2212
PFUND, A. H., 2305
PHILLIPS, D. C., 2780
PHILLIPS, M., 2628
PICCIOTTO, E., 2642, 2842
PIELEMEIER, W. H., 2832
PIERCE, A. K., 2146, 2331
PIERCE, J. R., 2589
PIEUCHARD, G., 2303
PINSKER, Z. G., 2795
PIPENBERG, K. J., 2788
PIRENNE, J., 2442
PLOCH, W., 2561
PLOTNIKOW, J., 2634
PODGORETSKIĬ, M. I., 2524 2545
POEVERLEIN, H., 2601
POLACHEK, H., 2265
POOL, M. L., 2655
POPPEMA, O. J., 2630
PORFIREVA, N. N., 2769
POROD, G., 2487
PORTER, G., 2753
PORTER, J. G., 2124, 2131
POTAPENKO, V. E., 2462
POUND, R. V., 2629
PRANDTL, L., 2737
PRASAD, C., 2165
PRENTICE, J. P. M., 2133–4
PRESCOTT, J. R., 2547
PRESTON-THOMAS, H., 2241
PRICE, D. J., 2374
PRIME, H. A., 2843
PROCTOR, W. G., 2627
PRYCE, M. H. L., 2562, 2574
PUTMAN, J. L., 2640
PYATT, E. C., 2419

QUERZOLI, R., 2518

RACHINGER, W. A., 2727
RAE, E. R., 2657
RAFFLE, J. F., 2521
RAMANAMURTI, M. V., 2480
RAMSEY, W. H., 2803
RANDALL, J. T., 2830
RASKIN, Sh. Sh., 2770
RATTE, H., 2236
RAUTIAN, G. N., 2387
RAWER, K., 2599
RAYNER, G. H., 2586
RAZORENOV, L., 2544
REED, C. A., 2751
REID, J. D., 2284
REIFMAN, A., 2817
REINEBECK, L., 2338
RESHETNIKOV, M. A., 2434
REUTER, A., 2440
RICE, O. K., 2417
RICHARDSON, E. G., 2276
RIESCO-MACCLURE, 2831
RIGHINI, G., 2317
RIOU, M., 2656, 2661
RIVLIN, R. S., 2723
ROBBERTSE, W. P., 2267–8
ROBERTS, S., 2761
ROBERTS, W. O., 2144
ROBERTSON, B. E., 2655
ROBERTSON, J. M., 2791
ROBINSON, J. V., 2214
ROCARD, Y., 2255, 2382
RODEWALD, H. J., 2207
ROGERS, D., 2780–1
ROGERS, F. T., JR., 2735
ROGERS, M. M., 2735
ROGERS-LOW, B. W., 2789
ROMAND, J., 2345
ROMANOVSKY, V., 2738
ROQUET, J., 2583
ROSS, M. A. S., 2289
ROTHERY, J. L., 2578
ROUX, M., 2569
ROY, R., 2828
ROZENTAL, J. L., 2548
RÜCHARDT, E., 2458
RUDERMAN, I. W., 2695
RUDERMAN, M., 2685
RUMER, YU. B., 2177
RUTGERS, G. A. W., 2290
RYVKIN, S. M., 2460

SAILOR, V. L., 2666
SALA, I., 2797
SALKA, O., 2826
SALMON, O. N., 2792
SALVETTI, C., 2676
SAMUEL, I., 2614
SANKIN, A., 2308
SARYCHEVA, L. I., 2557
SATO, M., 2204
SAVIN, F. D., 2535
SCHATZMAN, E., 2143, 2159
SCHAWLOW, A. L., 2624
SCHEELE, W., 2213
SCHEER, M. D., 2411
SCHEIL, E., 2702
SCHESSL, K. E., 2702
SCHIELTZ, N. C., 2788
SCHOEN, L. J., 2411
SCHOENBERG, M., 2687
SCHRIEVER, W., 2751
SCHRÖDER, H., 2368
SCHÜLER, H., 2338
SCHUMANN, W. O., 2590
SCHUR, YA. S., 2582
SCOTT, J. F., 2342
SCOTT, W. E., 2655
SCOTT BLAIR, G. W., 2736
SCROCCO, E., 2325
SEABORG, G. T., 2635
SECHKAREV, A. V., 2770
SEEGER, R., 2265
SEELIGER, R., 2184, 2812
SEN, S. N., 2603
SENGUPTA, S., 2332
SEVERNYĬ A. B., 2385
SHAÏN, G. A., 2163
SHAMIM-AHMAD, S., 2480
SHAPIRO, I. C., 2553
SHAPLEY, A. H., 2144
SHAPOSHNIKOV, I. G., 2263
SHARBAUGH, A. H., 2349
SHARONOV, V. V., 2136
SHCHIPANOV, P. K., 2726
SHEKHTER, A. B., 2731
SHEPPARD, P. A., 2808
SHERWIN, C. W., 2692
SHIFFMAN, M., 2223
SHKLOVSKIĬ, I. S., 2141–2
SHREIDER, E. YA., 2309
SHUKLA, B. M., 2481
SHULL, C. G., 2691
SHURCLIFF, W. A., 2300
SIEGERT, A. J. F., 2253
SILLÉN, L. G., 2785
SIMANOUTI, T., 2362, 2610
SIMMONS, B. D., 2272
SIMPSON, J. A., 2568
SINCLAIR, D. A., 2311
SINGH, R. N., 2823
SINSHEIMER, R. L., 2342
SIRKAR, S. C., 2603
SKRIPOV, F., 2771
SKRIPOV, F. I., 2770
SLATER, J. C., 2467
SLETTEBAK, A., 2150
SMAKULA, A., 2730
SMITH, A. L., 2356
SMITH, F. A., 2315
SMORODIN, YU. A., 2534
SNAVELEY, B. L., 2824
SNELLMAN, O., 2604
SNOW, W. B., 2287
SNYDER, H. S., 2552
SOEZIMA, Y., 2370–2
SOKOLOV, S. P., 2535
SOKOLOV, S. YA., 2281
SOUTIF, M., 2623
SPALDING, D. B., 2412
SPERDUTO, A., 2668
SPERRY, P. R., 2767
SQUIRE, C. F., 2463
STAHLY, E. E., 2306
STAINES, E. N., 2398
STAIR, R., 2810
STAPLE, W. J., 2363
STAUB, H. H., 2696
STEENLAND, M. J., 2630
STEKHANOV, A. I., 2361
STENGER, E., 2840
STEVENS, K. W. H., 2573–4
STEVENS, W. H., 2749
STEWART, K. H., 2607
STOPS, D. W., 2397
STRAIT, E. N., 2668–70
STRANG, C. D., 2206
STREET, J. C., 2530
STRUVE, O., 2167
STUDER, F. J., 2296
SUESS, H. E., 2744
SUKHOV, L. V., 2554
SULZER, P., 2347
SUWA, S., 2324
SVESHNIKOV, B. YA, 2360

TADAYON, J., 2384
TAMARKIN, P., 2275
TANFORD, C., 2407
TASCHEK, R. F., 2700
TAUB, A. H., 2265
TEMPLE, R. B., 2314
TEN BRUGGENCATE, P., 2158
TEN SELDAM, C. A., 2252
TERMINASOV, YU. S., 2720
THACKERAY, A. D., 2161
THEWLIS, J., 2690
THIRION, J., 2664
THOMAS, A. M., 2757
THOMAS, G., 2330
THOMAS, L. H., 2403–4
THOMPSON, H. W., 2343
THOMSON, W. T., 2260
TIMASHEFF, S. N., 2381
TIMMA, D. L., 2320
TINO, 2204
TIRUVENGANNA RAO, P., 2326–7
TISZA, L., 2254
TOBEY, A. R., 2538
TODD, S. S., 2430
TOLANSKY, S., 2740
TOLHOEK, H. A., 2650, 2682
TOLLESTRUP, A. V., 2672
TORALDO DI FRANCIA, G., 2377
TOWNES, C. H., 2618

AUTHOR INDEX—*continued*

Tralli, N., 2662
Traub, E., 2706
Treanor, P. F., 2145
Trent, P. T., 2537
Tretyakov, F. I., 2731
Trilling, L., 2226
Trocheris, M. G., 2585
Tsai-Chu, 2555
Tuck, J. L., 2505
Tuominen, J., 2140
Turner-Jones, A., 2789
Turnock, R. C., 2843

Unna, P. J. H., 2229
Unsöld, A., 2167
Unthank, H. W., 2139
Urick, R. J., 2272
Ursell, F., 2227–8

Vaĭnshteĭn (Weinstein), B. K., 2794
Valkov, V. I., 2344, 2611
van Bronkhurst, A., 2568
van Hove, L., 2199
van Itterbeek, A., 2426
van Name, F. W., Jr., 2522
Van Valkenburg, H. E., 2280
Veksler, V. I., 2548
Venkiteshwaran, S. P., 2806
Vergnolle, J., 2750
Vernov, S. I., 2542
Vernov, S. N., 2534–5, 2541
Victoreen, J. A., 2483
Viguier, M. G., 2217
Vlasov, K. B., 2582
Vodar, B., 2345
Vogt, E., 2606
von Kármán, T., 2221
v. Laue, M., 2466

Wachtel, I. S., 2814
Wadley, T. L., 2822
Walker, D., 2520
Walker, J., 2649
Wang, A., 2578
Wang, C.-T., 2247
Warshaw, S. D., 2509
Watson, A., 2209
Watson, R. B., 2595
Wattenberg, A., 2675
Wattenberg, D., 2132
Weale, R. A., 2346, 2373, 2833
Weekes, K., 2819
Wehner, G., 2511
Wei, J., 2551
Weidner, R. T., 2572
Weimer, D. K., 2248
Weiss, P. R., 2572
Weisskopf, V. F., 2678
Weissler, A., 2224
Wells, H. W., 2815
Welsh, H. L., 2363
Wert, C., 2705
Wessel, W., 2196
Westfold, K. C., 2600
Wexler, A., 2464, 2805
Whalley, E., 2237–8
Wheatley, P. J., 2409
White, G. R., 2814
Whitmer, C. A., 2572
Whitrow, G. J., 2180
Whittemore, W. L., 2530
Whytlaw-Gray, R., 2240
Wieland, K., 2340–1, 2347
Wilchinsky, Z. W., 2711
Wilford, S., 2448
Wilke, C. R., 2402
Wilkins, F. J., 2427
Wilkins, J. J., 2502
Wilkinson, D. H., 2698
Wilkinson, P.G., 2709–10
Wilkinson, R. G., 2653–4
Williams, J. H., 2700
Williams, R. C., 2714
Wilson, E. B., Jr., 2312
Wilson, R., 2519
Winch, G. T., 2388
Winn, E. B., 2510
Winslow, W. M., 2447
Winter, E. R. S., 2237–8
Witt, H., 2762
Wohlfarth, E. P., 2567
Wolf, E., 2379
Wollan, E. O., 2691
Wood, W. A., 2727
Woods, S. D., 2398
Woodward, L. A., 2365
Wucher, J., 2571
Wurm, K., 2157
Wyly, L. D., 2666

Yang, C. N., 2686
Yoffe, A. D., 2410
Yomosa, S., 2445
Young, C. J. T., 2287
Young, C. T., 2507
Young, R. W., 2277
Yu, F. C., 2627
Yudowitch, K. L., 2489

Zahradníček, J., 2170
Zatsepin, G. T., 2543, 2548, 2557
Zeffert, B. M., 2423
Zeldovich, Ya. B., 2406
Zener, C., 2705
Zingerman, A. S., 2470
Zirkler, J., 2138
Zoltoev, K. D., 2232